THE

ELECTRICAL REVIEW.

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THE

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1900

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THE COAL CRISIS.

THE supremacy of the English nation may, without exaggeration, be said to be due to the natural coal resources in Great Britain, and the probable duration of our coal supplies is a subject, the importance of which must appeal very strongly to every thinking man.

An era of industrial activity has commenced which, reacting upon railways, steamships, and factories throughout the world, has brought about an increase in coal requirements which could not be foreseen and provided for. As a result the supply is short, and prices rise. So far we are face to face with a situation which possesses no startling features in itself, and which is merely the outcome of the inflexible results of disproportion between supply and demand.

Coal is a commodity which in times of threatened scarcity does not admit of much economy in consumption. Gas companies, railway and steamship companies, manufacturers, and others in similar positions cannot do without their coal supply. The statutory obligations under which gas, water and electric light companies work, render it incumbent upon them to keep up their stock and reserve of coal at a cheap rate if possible, but at any price if needs must. It is quite clear, therefore, that such consumers are abnormally sensitive to the effects of any scarcity of supply, and upon any indication of possible serious shortage, immediately increase their purchases with a view to secure a supply before the big rise in prices takes place. This condition of semi-panic operates, of course, most powerfully upon the rise in prices, but if, as is most probable, the present abnormal demand is very largely due to "precautionary" purchases, and the demand is, therefore, to a great extent a spurious one, and largely in excess of actual existing requirements, the reaction —when it comes—will be of a serious character to the owners of collieries.

From the Home Office records it appears that the average estimated selling price of the total output of coal in Great Britain was nearly 5s. per ton, the average official value for the Scotch output being 3s. 11d. per ton. The result of the audit of the books of the South Wales owners published at the end of May shows that an increase of 13¾ per cent. on the standard rates is secured to the miners in that district, making a rate of pay of 48¾ per cent. above the wages paid in 1879. This is the highest rate paid since 1891, when it stood at 53 per cent., and miners' rates in all districts are now very much the same as those paid in 1890-91. The principle upon which these rates are arrived at shows that someone is making a large profit; but as a rule these profits have not gone into the pockets of the owner, but, to a very large extent, particularly in the house coal trade, into the pockets of the middleman. The railway companies, who are very large coal consumers, carry their own coal to wherever they may require it, and the actual burden upon them of an increased cost at the pit's mouth need be but slight relatively.

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On the other hand, steamship companies and manufacturers who do not possess transport facilities of their own between the spot where coal is raised and the place where it is to be consumed are necessarily very much in the hands of the middleman, who also fixes his own profit upon coal exported, but speaking generally, it may safely be said that the present price of coal is due entirely to the desire of intermediaries to take advantage of the abnormal demand. Nor can they be blamed. It is a fundamental business principle to buy in the cheapest market and sell in the best. Sentimental considerations must be left out of account altogether. It must be remembered that a good year for prices like the present has to compensate for many lean years, and when the price of coal was very low, as in 1888, the railway and other carrying companies did not see their way to reduce the cost of carriage. However, there is certainly no such rise in the price of coal at the pit's mouth as would warrant *per se* the relatively enormous advance in the prices of all classes of coal to the consumer. The Coal Exchange deals in shilling increases per ton, the price at the pit's mouth varies by pence.

The supply of coal in the world is a fixed quantity pending some further convulsion of nature, and every ton of coal raised leaves one ton less in our store. Whether or not the extent of our coalfields has been under-estimated or exaggerated, it is quite impossible for anyone to say, with any great degree of accuracy, since those who profess to have special knowledge on the subject seldom agree in their calculations within a few thousand million tons, and subsequent computations by equally competent experts to those who reported to the Royal Commission have shown that the amount adopted by the Commission is under-estimated.

In Lanarkshire the visible supplies are being so rapidly drawn upon that the manufacturers of Glasgow will undoubtedly have a more or less serious situation to face within a comparatively few years. In 1892 the available supply of what might be termed "cheap" coal in the Lanarkshire coalfields was computed at 265,000,000 tons, which, at the rate at which it is being worked at present, would be exhausted in 24 years. A similar depletion of available supplies is taking place in other of our well-known coalfields, notably in South Staffordshire, and also in parts of Durham and Northumberland. This does not necessarily involve that the seams will be worked out in these districts, but that the limit of depth at which the seams can be worked at a profit at the ruling price of coal will have been reached.

With regard to the future of our coal supply, it must not be forgotten that the basis upon which experts compute the amount of workable coal in sight is governed by the cost at which coal can be raised, having regard to the ruling price at which it can be sold. It is, therefore, clear that any economy in the cost of production will bring bodies of coal within the limits of "workability," which before were considered impossible.

The cost of winning and raising coal depends upon the extent to which the miner is willing to work, and the efficiency of the apparatus employed in cutting and moving the coal.

As to the question of labour, statistics show that, on the average, miners work a little over five days per week. They make enough money during that time to satisfy their wants, and therefore they do not work one moment longer than is sufficient to fulfil this condition. As long as miners' wages are based upon profits earned by the owners, it is clear that higher prices will tend to discourage longer hours of work, and thus aggravate the position from the point of view of the consumer.

As regards possible economies in the methods of and apparatus used in winning and raising the coal, more is to be said than can be introduced in these columns, but generally it may be pointed out that hauling and pumping can, in very many cases, possibly in the majority of cases, be more efficiently and economically performed by the application of electrical energy than by the methods now in vogue. Recently experiments have been made in coal cutting by machinery, and this is stated to have been the means of turning a loss into a profit at a mine where the seam was only 2 feet 8 inches thick.

By the introduction of electric haulage in a colliery in Lanarkshire, the total cost of haulage was reduced by over 50 per cent. as compared with the cost of horse haulage which had hitherto been in use. Evidently this saving must have considerably extended the range of possible working of those coal seams.

Again, the opening up of new pits, notably in the districts passed through by the newly completed Lancashire, Derbyshire, and East Coast Railway, will not be without its effect upon our available supplies.

Any further serious rise in the price of coal, or even the maintenance of the present price, would operate as a healthy stimulant upon the inventive faculties of those whose minds are endeavouring to reduce to a practical form some of the many fuel-saving devices which are now shelved because their use is not an absolute necessity.

The amount of workable coal in Great Britain may, therefore, be greatly increased in this way, and the days when we shall only find coal under glass cases in museums, relegated to a more distant future.

These considerations, however, do not materially assist in relieving the acuteness of the present situation, and a remedy which probably suggests itself to many minds is to put a tax upon coal exported. Of course, to tax exports is considered to be a fundamental economic error, and no doubt on general principles this is true, but in the days of John Stuart Mill things were rather different even when looked at from an economic point of view. It would not be easy to say what was the rate of increase in coal output during his lifetime, but it would be safe to say that it was insignificant compared with the 252 per cent. increase during the last 30 years. What it may be during the next 30 years no one would care to venture to suggest. Our experts have calculated the "probable" duration of our coal supply upon existing rates of output, but with the experience of recent years in our minds, who can foretell what our requirements will be in the near future? Consider the coaling of our ships of war. At present Welsh smokeless coal figures prominently upon the Admiralty list, but it is just this class of coal that finds so ready a market for export. Should it be necessary for our Navy to be kept in a more active state in the future than it has been in the past, a state of affairs not wholly incompatible with the march of events, we may find our supply of suitable fuel—at anything like a fair price—inconveniently small.

We now export nearly 30 per cent. of our total coal production, and most of this goes to countries which use it in the manufacture of articles in which they compete with us in the world's markets. From this point of view the restriction of coal exports would be useful. The amount of the restriction would naturally depend upon the amount of the tax imposed, and if this is calculated with due regard to the possibility of competition from other sources, the effect need not be an evil one. Thus the country which is most rapidly increasing the amount of coal raised is America, and the main danger of competition would appear to be in that direction. The difference between the cost of coal at the pit's mouth in America and in England is not more than 1s. to 1s. 6d. per ton normally in favour of America, and most of the coal in Great Britain is carried from the pit to the ship's hold at a cost not greater than 1s. 6d. per ton. An export duty of 2s. per ton on Welsh coal would not, therefore, be sufficient to kill our export trade by enabling America to supply our present markets, but would operate advantageously in checking the quantity of this valuable mineral which is sent out of the country, and thus tending to increase the cost of manufacture of many competing products. Supposing the duty on all classes of coal exported averaged 1s. per ton, the revenue accruing therefrom—calculated on last year's exports—would be about £3,000,000. The general principle involved in taxing exports is, of course, an important one, but we cannot help expressing the view that having regard to the certain considerable increase in our Navy, a measure designed to prevent the means of using these warships from passing into other hands is, at least, worthy of very serious consideration.

THE TELEPHONING OF LONDON BY THE POST OFFICE.

(*Concluded from page 775.*)

The ducts will be built in cement to any required number and in different groupings. After a trench has been excavated to the required depth, 6 inches of concrete will be laid, in the centre of which will be embedded one or two T-irons, according to the number of ducts in the group. After this concrete bed has set, the first tier of ducts will be laid, bedded in about half-an-inch of cement, and above this the second tier will be laid, also bedded in half-an-inch of cement, and so on for every subsequent tier till the nest is complete. On each side of a group of conduits there will be a wall of concrete, and above the top tier a layer of concrete. These side walls and the top layer of concrete will vary in thickness from 4 to 7 inches according to the number of conduits in a trench.

Fig. 4 shows a section of a group of 12 ducts.

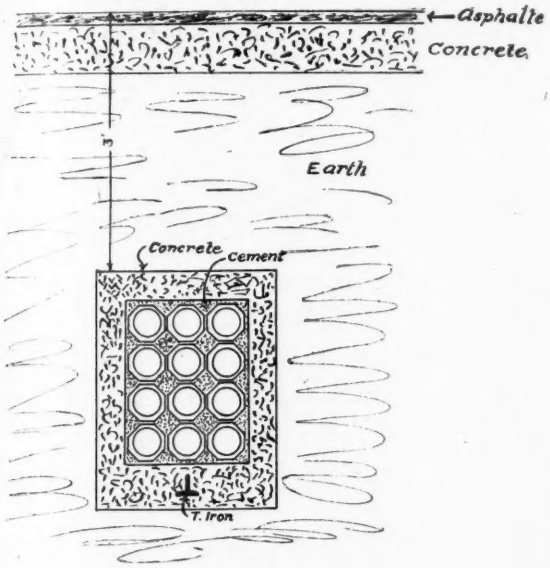
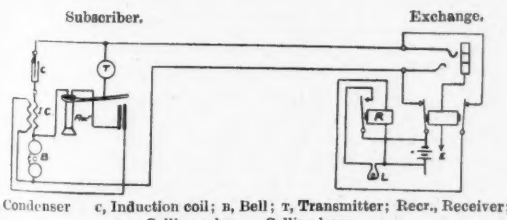


Fig. 4.

In all cases these ducts will carry the main cables as distinguished from distribution cables, which will be branched off from the main cables at jointing chambers into cast-iron pipes.

Jointing-Chambers.

Jointing-chambers, or manholes, as they are more commonly termed, will be of two classes, one class for the roadway, and another for the footway. Roadway manholes will be larger, and constructed in a more substantial manner than any similar class of work yet attempted in this or possibly in any other country. They will be built of 14-inch brickwork in cement, roofed with steel troughing and steel joists, and the manhole entrance will have a cast-iron frame fitted



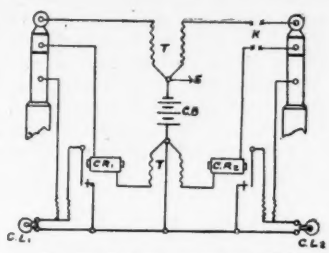
C, Condenser c, Induction coil; B, Bell; T, Transmitter; Recr., Receiver; R, Calling relay L, Calling lamp

Fig. 5.

with wooden blocks. The dimensions will vary with the number of cables to be brought into a manhole, but three standard sizes will be 4 feet wide, 8 feet long, and 5 feet 6 inches deep (to take 18 cables); 5 feet 6 inches × 8 feet × 6 feet (to take 28 cables); and 7 feet × 8 feet × 6 feet (to take over 28). For the City work the last named will be the most common size used, but there will no doubt be some special manholes of larger dimensions.

The footway manholes will be of 9-inch brickwork, with York stone roofs resting on light steel joists, with the ordinary cover frames with stone slabs. The dimensions of this class of manhole will be considerably less than those for roadway work, and will be governed more by the space available than by the number of cables.

The large manholes in roadway and footway are for the main cable work, and are to be built at an average distance apart of 150 yards, but of necessity the intervals between the manholes in the City will be much less in many cases. These main jointing-chambers, when they are in the roadway, are to be connected with each footway, and when the man-



T, Transformer; C B, Common battery; C R_1, C R_2, Clearing relays; C L_1, C L_2, Clearing lamps; K, Speaking and ringing keys.

Fig. 6.

hole is in one footway it is to be connected with the opposite footway. In both cases the connection will be made by means of cast-iron pipes.

These connecting pipes will contain the cables which are to be used for distribution purposes, and which will be carried along the footways in cast-iron pipes. At intervals depending on the number of subscribers on the various routes small boxes will be fixed in the footway, and from these the cables or wires to serve subscribers will be carried into the buildings.

Switchboards.

The switchboards for the Central Exchange will be fitted to accommodate 10,000 subscribers, whilst the switchboard for what may be termed the "inner" sub-exchanges, such as Westminster and Kensington, will have a capacity of 2,000, but will be so constructed as to admit of their being added to as business develops.

For the "outer" sub-exchanges the switchboards will, as a rule, have an original capacity of 600, but will be made so that additional "panels" may be added as required.

Central Battery System.

The system of working to be adopted in the City Exchange and the inner sub-exchanges will be that known as the "central battery system." As the title implies, a central or common battery, usually 24 volts, is fixed at the Exchange, so that no battery is required at a renter's office. This mode of working is especially adapted for large exchanges where secondary cells are available and where the subscribers' circuits do not exceed two miles in length. Under such conditions this system of working is very efficient. For the outer sub-exchanges and for long subscribers' lines the common battery system will not be employed.

In central battery working the apparatus arrangements are such that when the receiver at the subscriber's end is on its hook the circuit there is not continuous, but is made through a condenser and magneto bell (this is to admit of a call being received), whilst at the Exchange end the lines are joined together through a relay and battery. The action of lifting the receiver by a subscriber makes the circuit continuous through the speaking apparatus. This sends a current through the Exchange relay and thus causes a lamp to light, so gaining the attention of the operator automatically.

At the Exchange the cords used for making connections have transformers joined across them, the coils of these transformers being divided at their middle points, and between the halves of the coils the common battery is

placed. These transformers and the common battery thus respectively take the place and fulfil the function of the induction coil and battery which are required at the subscriber's end for the speaking circuit in the ordinary system of working. In the common battery system there is still an induction coil in the subscriber's telephone set, but its function is a "hearing," not a "speaking" one. "Clearing" lamps are connected up with the cords in such a way that the act of replacing the subscriber's receiver upon the hook automatically causes a lamp to light, and the operator disconnects, thus restoring the subscriber's line to the normal.

Figs. 5 and 6 show diagrammatically the connections at the subscriber's end and at the exchange.

This system has been extensively adopted in the United States with excellent results. It has several advantages. The signalling is entirely automatic, and this reduces to a minimum the demand upon the time, patience, and technical knowledge both of the renter and the Exchange operator; the absence of batteries from the subscriber's office saves the space usually allotted to these articles, which are often looked upon as objectionable adjuncts to the telephone, and hitherto tolerated simply because they have been considered indispensable. Further, as the majority of faults at the subscriber's end are at present found to be in the battery circuit, the subscriber will be less troubled by visits from a lineman, and, incidentally, it may be remarked that this means to the Post Office a saving in skilled labour and in battery materials.

Rates.

The Post Office telephone rates for London have not yet been published, but they will probably be based on the "toll" rate system already announced by the Post Office for the provinces, as against the "flat" rate system which has hitherto been in vogue in this country. The annual rental quoted by the Post Office for provincial towns is £5 to cover 500 free calls, with a small graded charge for calls beyond that number.

The toll system will obviously appeal at once to the small users of the telephone. It will undoubtedly, however, very shortly find favour with large users as well, for it will have a tendency to induce the renter, but more particularly his staff, to be more careful with "calls." Under the present flat rate system indiscriminate use is made of the telephone by all and sundry. Even the office-boy does his "little talk" by means of it. The result is that many business calls are postponed or cancelled altogether, and the interests of the firm suffer in consequence. This has been borne out by statistics from America and Switzerland, which proved that with a flat rate system the percentage of "ineffective" calls greatly exceeded the number under the toll rate system which is now in vogue in both these countries.

In America it is found that more real business is done, and more expeditiously done, under the new *régime*, than under the old. It is, therefore, safe to assume that a system which has commended itself to the sharp business men of America, a country which is, by the way, at present much ahead of us in matters telephonic, will soon become popular with the commercial community on this side of the Atlantic.

LEGAL.

The Jandus Arc Lamp and Electric Company, Limited, *v.* Johnson.

(*Concluded from page* 782.)

Monday, May 7th.

Mr. Herbert John Marcus proved the execution of an agreement of March 23rd, 1897, between the Electric Arc Light Company and the Jandus Arc Lamp and Electric Company.

This closed the plaintiffs' case.

Mr. Bousfield said that with reference to this claim of title, what they had to look at was what was the position of things on March 24th, 1898, and the question was, of course, what controlling patents they then possessed. At the date of the license the maker was taken entirely on trust. They were getting certain patents, those patents were to be controlling patents. They asked the defendant to take a license, and he did so on the assurance that he was going on with the rest of the trade, and was going to get it on the same terms. They had a remarkable form of license, and the plaintiffs were no more entitled than they were to go outside its terms. At the date of the license he should say that as to the Howard patent they had not got it, and had not the right to get it, and on this question of title he should submit the plaintiffs had made no case.

Mr. Justice Farwell: If you satisfy me that they had not got it either in law or equity, then I shall be with you.

Mr. Bousfield said the agreement of March 23rd recited that the vendor company claimed to have certain rights in the Howard patent. What had become of those rights?

Mr. Justice Farwell: The legal title being in Marks, and an assignment being duly registered—that would be conclusive, would it not?

Mr. Bousfield said that was *primâ facie* evidence of the title, but it came after the date. They could have no further facts after the date of the license. In this document there was a clear notice to all the world and to the parties that it was the vendor company which claimed the right to the Howard patent. Marks's agreement was a personal agreement under seal to carry out the provisions of the agreement so far as related to matters within his control. He took it that meant that he would make a struggle to get the patent for the Electric Company.

Mr. Justice Farwell: It meant, if he got the patent, he would convey it according to the agreement.

Mr. Bousfield said the two points he would put were, first, that on the face of the document the Electric Arc Light Company were owners of the patent, and it must be shown that their rights were discharged before a title could be shown, especially when it was an equitable title his friend was relying upon. The next point was, that the title they were relying upon was a title which came through this personal agreement of Marks, which personal agreement did not appear to have anything to do with the assignment of the patent, but appeared to be an agreement for services—a personal agreement. Then he said it was *nudum pactum*, and that it could not be enforced. Then there was a further point, and it was that, assuming that Marks and the Electric Arc Light Company were the same persons, and assuming, therefore, that on February 19th, 1898, not merely Marks, but the Electric Company had got this patent, he contended that even then there was no equitable title in the licensors. Even if the Electric Arc Light Company had got the patent instead of Marks, the Jandus Company could not have enforced specific performance.

Mr. Justice Farwell: It really goes to the root of the whole matter if you are right. Assume that you could not have specific performance of an agreement to do the best you can to get the patent, because it is too vague, or it is personal service. Suppose he did get it. Cannot you, after that, get specific performance?

Mr. Bousfield said that was a point for his Lordship to decide. Learned counsel then directed his Lordship's attention to the specification, and pointed out differences which he contended existed between the plaintiffs' and defendants' apparatus. The specification spoke of "the enclosed air and gases between the outer and inner envelope make the differences of temperature on the two sides of the arc-enclosing envelope less, and thus protect it." It was wanted therefore to have an enclosed space, which was got by what was called a closely fitting conical reflecting hood. Now the defendant found if he enclosed his like that he cracked the outside globe, and therefore what was done was this:—First of all he had not got that conical hood business and that feed opening in it, and what he had was a globe, as he was entitled, and as everybody was entitled to have a globe to keep draughts off, and he provided for the free escape of the heated air from the globe for the practical reason not merely because he did not want to do what was done by the specification, but for the very good reason that if he did not do it, it was found by experience that the top screw of the outer globe cracked off.

Mr. Adolph Wunderlich, recalled, said he was quite familiar with what had been done in reference to enclosed arc lamps. These lamps had been practically his design.

When you started devising the lamp that you are making, D.C. 1., did you have the specification handed to you?—Not that I can remember, but I have had the specification.

What year did you start devising this arc lamp?—About 1898, I should say.

Did Mr. Johnson tell you to devise a lamp?—Yes.

What did he tell you to do?—He told me he thought there was a large scope for enclosed lamps and that there was no reason why we should not make one.

Did he tell you that he had a license under Howard's?—Not that I remember.

Did you have Howard's lamp before you when you made your lamp?—No.

I put it to you that in devising this lamp, one of the objects you had in view was to try and get outside Howard's if you could?—No, I did not attach any value whatever to Howard's specification at any time.

You never believed it to be of any good?—No, of any real utility.

Mr. Gray summed up the plaintiffs' case. He contended that the two claims must be construed, for the purposes of infringement, so as not to exclude mechanical equivalents, and if that was so, he submitted they were entitled to succeed.

Judgment.

His Lordship, in giving judgment, said: I think the defendants in this case have raised every conceivable objection that is possible, or could possibly be raised. The first point made by Mr. Bousfield was on the construction of the agreement. He says that there is an interest there recited to be believed to be in the Electric Arc Light Company, and that is not got rid of. It seems to me the short answer to that is that I had here the Patent Office register. It shows

that the Jandus Company are registered as sole proprietors under an assignment from Marks, and were so registered on May 16th, 1898. The second point which he takes is this: He says the agreement is *nudum pactum*, because in effect the Jandus Company took from Marks, and from the Electric Arc Light Company. I can only say so far as *nudum pactum* is concerned, I really do not follow it. Marks executes a memorandum at the end of the agreement, in which he says: "I personally agree to carry out the provisions of this agreement, so far as relates to matters under my control, as though I had been an original party to this agreement." That agreement contains, amongst other things, a provision that "The purchaser company will pay to the vendor company a further sum of £1,500 upon the vendor company assigning or obtaining an assignment from the purchaser company of the said Howard patent." How could that be said to be a *nudum pactum*, when it is in effect an agreement by Marks in consideration of the payment at his request to the Electric Arc Light Company to procure to be assigned the patent, I fail to see. That point seems to me to come to nothing. Then there was an ingenious point suggested, that this was an agreement of which you could not get specific performance, and therefore it was said if you could not get specific performance you did not get the equitable title at the date of the license, because it is by reason of your being able to get specific performance that equity considers that as done which ought to be done, so that the equitable title passes. Mr. Bousfield pressed upon his Lordship that this was really an agreement to give services, and not an agreement to assign a patent. But he could not shut his eyes to what was the true intent of clauses 2 and 3, which Mr. Bousfield read of the agreement, although there was this to be said in Mr. Bousfield's favour, that the parties had some inscrutable reason for not going on in terms to say that if and when the Electric Arc Light Company should get that Howard patent they would assign it. But, continued his Lordship, I find these words by implication in clauses 2 and 3. The argument pressed upon me was this, that it would be only damages and not specific performance. That argument in itself assumed a contract to assign, because you could not get damages for breach of a mere agreement to do the best you could, if you had actually done the best you could to get the assignment, and, therefore, the only matter for which damages could be recovered would be for not assigning the patent when you got it. That is to my mind the true meaning of the agreement. And if that be so, if it be the effect as Mr. Bousfield put it that you could only get damages, it is fatal to him because whether the remedy be damages or specific performance, the right of action is the same. That leads me to the point of substance in the case which is a question whether the article made by the defendants infringes the invention of the plaintiffs so as to be really made within the license. Now, I have heard an argument which would have had very considerable force if it had been addressed to the validity of the patent, but it is not open to the licensee, and the whole of the struggle was to get in evidence by putting in former specifications, and the struggle to put in evidence which I have overruled, and to which Mr. Bousfield returned again and again is entirely with a view to show that the patent was not good. Over and over again in the course of the witnesses' evidence, and in the course of Mr. Bousfield's address it was plain that what he was striving for was to do that. Now this is not open to him. He is bound to admit that the patent is good, and that being so, I am proposing to construe this patent simply and solely by the words the parties have used contained in the four corners of the specification. What I have to consider is, whether, in the fair meaning of this patent, the defendants' lamps are infringements or not. On the evidence as it stands—leaving out Mr. Wunderlick's, as to whom I have already made some comments, and I do not like to say a thing of that sort twice—it seems to me that there is no dispute really. First of all, it is "an arc lamp having its arc enclosed in a transparent or translucent envelope, closed airtight on all points below the arc." His Lordship went on to say that everybody agreed there that "closed airtight" did not mean hermetically sealed, inasmuch as he had had explained to him the object, on one side, of preventing a current of air arising, and avoiding, as far as possible, contact with the carbon, and on the other side, to allow some escape of the hot gases, which otherwise might cause an explosion. He had got what was reasonably plain on the face of the specification—a provision by which you could not have a hermetically sealed enclosure, nor could you have one, nor did you desire to have one, which was open to all the winds of heaven. The invention was of something which gave a mean between the two. He was invited to say that "closed airtight on all points" was so airtight on all points below the arc as to necessitate the provision of a plug at the top. He did not think that was a fair construction. The recital part of the specification showed that although the inventor dealt with arc lamps with enclosures and with valves, he also dealt with those where there may be an opening not by means of a valve. It was said, moreover, by one of the witnesses that provided with a plug at the top, would not apply to D.C. 1. On the evidence I find it does. I disregard that particular item of evidence, and I understood Mr. Bousfield to admit it. At any rate, whether he did so or not, I think it is so. Then we have some little light thrown on the meaning of closely fitting by the next words: "Having a closely fitting feed opening for deposit of carbon." It was plain to his Lordship, as Mr. Bousfield pointed out, that "closely fitting feed" there referred back to the closely-fitting feed mentioned on page 2, line 25, of the former specification, which was a "comparatively close fitting." So he had words which under the rules of construction allowed him to read as "comparatively" close fitting. All the witnesses agreed that it meant comparatively close fitting. To his mind D.C. 1 came within Claim 6, and it was said to come within Claim 12. He did not propose to go through the evidence in detail. It would be convenient to refer to it in another place if necessary, but he should like to point out that Prof. Thompson agreed with his Lordship's view. He thought that Howard had described all practical purposes for making the lamp. It seemed to his Lordship to be a plain case of infringement, and therefore there must be the order as asked.

Mr. MOULTON: There will be judgment for the plaintiffs on the claim for the account, and for payment of the royalties and costs.

His LORDSHIP: That is so.

Mr. GRAY: With regard to costs, my lord ——

His LORDSHIP: Yes, there is that particular item; I said I would not make them pay for that.

Mr. MOULTON: Yes; those costs of proving the title.

His LORDSHIP: You must pay any costs of proving the title. You ought to have produced that before. You cannot have an order for payment until you have got your account.

Mr. MOULTON: It will be an order for an account and payment of royalties then.

His LORDSHIP: Yes; when found Mr. Moulton. I do not think the form of your account is quite right when it says you seek an account of all lamps made under the license.

Mr. MOULTON: Made or sold?

His LORDSHIP: The Registrar points out to me that that is not the common form, "all lamps made or sold."

Mr. GRAY: Then, my Lord, they succeed as on two patents and they have only proved infringement of one patent.

His LORDSHIP: I do not think that has made any difference as to costs. I am not favourably impressed with the honesty of your defence. I am not disposed to give you any favour at all. I see no reason for making any difference.

CHAMBERLAIN & HOOKHAM *v.* THE CORPORATION OF BRADFORD.

(*Continued from page 784.*)

TUESDAY, MAY 8TH.

CROSS-EXAMINATION of Mr. Hookham continued.

Mr. CRIPPS: Just look at page 5, where we come to permanent magnets. "In place of electro-magnets as described and represented I prefer using for smaller installations permanent magnets, a number of bar magnets being substituted for the electro-magnets represented in the drawings, though I may use magnets of other shape or configuration"?—Yes.

Now, is not this model which I have got in my hands a model of what you call there a number of bar magnets with iron pole-pieces, which are represented by the black wood? (Handing the model to the witness.)

The WITNESS: The red wood is meant for steel magnets.

Steel bars?—Yes. That would produce the result that mine produces.

Cross-examination continued: No magnet of that form was used by the defendants. The defendants was another shape or configuration. The term "pole-pieces" used in his specification meant pole-pieces, or added pole pieces, as distinct from the magnet itself. There was nothing in his specification which showed that he contemplated a magnet without an added pole-piece. The witness stated that the principle of having an electrical generating machine "having a constant field and working on constant resistance or stated generally by any arrangement involving the motion of a conductor relatively to a magnetic field, the strength of the field being maintained constant and the current in the conductor being proportional to the rate of rotation" had been already explained and described by a great number of people. The merit he claimed was applying the principle to the electric meter. His first claim was an electricity meter for measuring currents consisting of an electromotor with constant field. For the purpose of measuring currents a constant field was necessary. If you wanted to measure energy a constant field was destructive.

Mr. CRIPPS: "Arranged substantially as hereinbefore described," as regards any of your arrangements, whether commutator or any other point. What I want to call your attention to is, that there is no arrangement in the defendants' meter which is anything like the arrangement that you have adopted in the motor part of it?—I am afraid that is hardly for me, but if you ask me I should say it is covered.

Cross-examination continued: The meter as used at Bradford had a practically constant field.

Mr. CRIPPS: Do let us consider. Supposing there is a variation in energy, the meter would show it, because the field would be inconstant?—Certainly.

But if you have no variations in your electromotive force and do not want to measure it, then you might get the same result with one machine as with another?—That is our case.

But if you want to measure energy, and have to measure it, then the defendants' machine is an inconstant machine, and it is essential that it is inconstant?—Yes, but Bradford does not want to measure energy.

Now in order to get constancy of field, you either have a saturated magnet or a permanent magnet?—Yes, or I give a third method, page 5, line 3: "In electrical circuits in which the electromotive force is practically constant, this degree of saturation in electro-magnets is not essential." Then I go on to say what I prefer.

Cross-examination continued: So far as the defendants are concerned in connection with the motor part of their machine, they neither had a saturated magnet nor a permanent magnet. He could not agree that they had no device whatever for obtaining a constant field. Bradford took the device of putting it upon a constant circuit; the motor itself, he agreed, had no such device.

I am taking the motor itself.—But you see we only attacked it where used at Bradford, where the field is practically constant,

I think we could soon dispose of the fallacy of that argument, but what you mean is that if you have a machine to measure energy, and

you make energy entirely constant in a number of cases, so far as it is energy, you do not care for it?—That is so.

Cross-examination continued: An electric brake with a permanent magnet was in no sense new at this time. He knew a case where a disc was used with the electro-magnetic brake, but he did not remember one with the permanent magnet.

Mr. CRIPPS now said he was going to the third claim. He thought it was the only other claim, as far as he knew, that any weight was put upon. He might, perhaps, tell his Lordship what the point was. It was hardly cross-examination, and it might be convenient for him to know that if the third claim was taken as an adjunct to the first, that was to say, in connection with the meter for measuring currents, he had no fault to find on disconformity or any other point. But if his learned friends were going to say that apart from the meter for measuring currents, this third claim was a sort of general claim for electricity meters generally, then he should have to point out that as far as the provisional was concerned there was no indication of that at all.

His LORDSHIP said that Mr. Moulton had made out no such case as that.

Mr. WALTER: We say that it measures energy, and if the energy is constant the E.M.F. is constant. In Bradford it is measuring current and nothing else, and in that current the E.M.F. is absolutely constant.

Mr. CRIPPS said that he would leave that point.

The witness was next questioned as to Siemens' energy measurer. The brake power there was from the fan, which could be seen at the bottom revolving in some fluid. There was what was called a series motor in connection with that fan.

I am putting to you that the motor there, as far as the motor is concerned, is exactly the same as the defendants—there is no difference?—It looks to me as if the armature carried the current to the meter.—Yes, I believe that is so.

Cross-examination continued: Could not anyone taking Siemens' energy measurer and putting in the electric brake for the fan have produced an energy meter like the defendants?—Well, apparently Siemens could not. Of course, it seems easy when it is done.

I put it to you, was not the practical difficulty simply the invention of a suitable form of commutator?—Oh, dear no, certainly not; there were other difficulties.

Cross-examination continued: The wattmeter was a meter for measuring energy.

Your attention has been called to Ayrton and Perry. Now I put it to you that every feature in the defendants' energy meter is found in Ayrton and Perry, and the only difficulty that Ayrton and Perry did not get over was the friction point?—I should say that almost every possible form is mentioned in Ayrton and Perry, and, of course, the defendants make a selection, but I think it has almost logically exhausted all the possible form in theory.

The WITNESS stated that he took exception to the learned counsel speaking of the Ayrton and Perry meter.—There was no Ayrton and Perry meter.

Then take the Ayrton and Perry specification, does not that describe everything that is necessary, and describe it accurately for the energy meter, except that it does not show a way of getting over friction?—I should have read it through from that point of view. I do not remember that it shows how to get the constant field for the brake in practicable form. I do not remember that, but that is the first point that occurs to me.

I am putting to you that in Ayrton and Perry you find everything that we have in the defendants' meter, except they do not get over the difficulty of friction, which has been got over in the defendants' meter?—You find a sort of suggestion of everything. I do not think you find anything that helps you towards making a meter, except a bare theory of the Foucault brake, which, of course, was a great thing to point out from the point of view of theory. I am not diminishing the value of that from the point of view of theory, but it did not help people to make a meter.

Cross-examination continued: Speaking from memory, he should have said that in 1887 Ferranti's was hardly a practical meter.

WEDNESDAY, MAY 9TH.

WHEN the hearing was resumed on Wednesday, Mr. HOOKHAM again went into the witness box and was further cross-examined by Mr. BOUSFIELD. Shown Munro's specification, he said that as regarded the theory of a meter, apart from the point of constancy of pressure, the theory was in that specification, but there was a great absence of detail. It did not even refer to the element of friction as a disturbing element, and probably the patentee there did not know of it at the time. The friction in the instrument which was made under that specification was 50 times greater than in his (Mr. Hookham's) meter.

Questioned as to Handford's specification (Edison's), the WITNESS said that in fig. 1 there was a disc in the form of a cap mounted on a little pivot against the big S in the middle. That formed the armature of the motor. As regarded the motor part of that, the principle was the same as his.

Mr. BOUSFIELD: That is to say, that you had to have a suitable electromotor rotating in a constant field?—I do not see any provision for procuring a constant field. He believed that Handford wanted to have a constant field. So far as he had a constant field, he would have the driving force proportionate to the current.—The brake portion in Handford was quite different to his.

Mr. BOUSFIELD then referred the witness to Weston's first specification and fig. 7. This he said was an indicator, and instead of metering ampere-hours it indicated by a pointer the number of amperes passing at the moment. There was a little cup in the middle in mercury. Instead of the current being able to rotate that cup continuously, it was only able to turn it until the resistance created by the spring was itself sufficient to turn the turning force of the current. Having done that it stopped there. For that he wanted a highly constant field. In Weston's specification there was what was called an electrical meter, and his plan of measuring the current passing was to cause a flow of mercury from one vessel to another. In order to get that, he wanted to have a powerful and constant magnetic field.

The WITNESS added that a motor with an armature working in a constant field was not his invention. That was found in two or three of the prior apparatus. Weston had the idea of large pole-pieces closely fronting, and the idea of winding his electro-magnets so that they were saturated. It was true that Handford wanted a constant field. His objection was that the winding, such as Handford had shown, would not give him a constant field.

Supposing I wanted to make a Handford meter, and for the purpose of getting the field constant I wind the magnets to saturation, thereby simply using the knowledge open to the world and outside my specification, do you say that your second claim would prevent my doing that?

The WITNESS replied that he did not think that saturation had occurred to this patentee. He thought it was a question of mere law. As a matter of fact, he did think that his second claim would prevent it.

Mr. BOUSFIELD asked the witness what he thought would be the result if he took a Siemens energy meter with a disc and used a known magnet to brake it. If it turned out to have a constant and powerful field substantially in the way or according to the instructions he gave, he should say it would be an infringement.

Mr. BOUSFIELD: Here is a known type of magnet, and it turns out to be strong enough and constant enough to do that. You say it comes within what you taught the world?—Yes, that is what I say.

Cross-examination continued: There was no construction in Deprez for producing an absolutely permanent and powerful magnet. He thought there was a great deal in putting the pole-pieces close together. To preserve the strength of a magnet it was necessary to keep the magnetic circuit closed. The closer the poles of a magnet were together the more complete was the magnetic circuit, and the less loss took place. That was common knowledge.

In answer to his LORDSHIP, Mr. BOUSFIELD said that the defendants' case was that magnets of the dimensions of the plaintiffs' were used for similar purposes before the date of plaintiffs' specification.

Mr. BOUSFIELD said that the defendants had had considerable research as to the different and best processes of manufacture for the magnets. They relied upon the ageing process for the purpose of getting the magnets constant. They had them magnetised up to the highest point. Then they were put on some rotating instrument which passed through boiling water and out of it again and again. That let down the magnetism some 15 per cent. In that ageing process the defendants found that they got the magnets practically constant. (To the witness.) In doing that we are not borrowing from anybody?—No; on the contrary, I think you are doing what is absolutely unnecessary. I have had a very large experience in this subject.

Mr. BOUSFIELD: Is it possible to make a meter for alternating currents according to the description given in your specification?—I think so.

The WITNESS added that he had never made a meter for alternating currents according to this specification. He could make such a machine on another plan and more cheaply.

Mr. BOUSFIELD: I put it to you that there is not sufficient description here combined with the common knowledge at the date to enable you to make an alternating meter which would work?—Yes, certainly it would. Take a Siemens meter and put on a brake disc, and if you follow my directions you will have a perfectly suitable meter for alternating current. Do that and the thing is done.

Mr. MOULTON re-examined the witness, dealing first with previous specifications. There were, he said, two classes of meters, those which measured current, and those which measured total power.

A spur wheel can be used for measuring current, can it not?—If I understand properly what a spur wheel is, it would have no brake at all.

Suppose you have a spring applied to resist rotation, then Munro's apparatus is capable of indicating current?—Witness agreed that could be done either by a spur wheel on a disc. That was, however, a case of indicating current, not adding up supply.

In reply to the judge, the learned counsel said he was suggesting that Munro was dealing with an indicator of current, and not with a meter at all.

WITNESS explained that the angle through which the wheel was turned was a measure of the current passing at the moment.

Mr. Justice FARWELL suggested that it would be better to take this evidence from an expert, which the witness did not represent himself to be.

In further examination, the WITNESS said that neither Munro, Handford, Ayrton and Perry, nor the two Weston's specifications, would have enabled persons in their day to make a practical meter. He did not think that Jamin's paper would put people in the way of making constant strong magnets, such as he himself referred to. For suitability for use in a meter, the union of constancy and power was necessary. To the best of his knowledge no one had before pointed out how suitable permanent magnets for an effective meter could be obtained. In his own specification he might have two magnets, of which one was strongly magnetised, and the other not so strongly magnetised. With regard to reversal of function in the armature in the field, it was, generally speaking, quite possible to take your choice whether you had the current through the field or through the armature.

Does that apply to a circuit of constant potential, such as an

electric light circuit. Is there then any difficulty in using either?—No.

WITNESS considered that in the case of a current which would vary greatly, the small current would be through the armature. In that case the saturation would be on the stationary part. Apart from the cost of energy, there would be no difficulty in that at all. Supposing for any reason it was desired to get saturation in the working part, it was by no means impracticable. A person reading the Hookham specification would, he believed, be able to do it if he chose to.

Mr. MOULTON intimated that he would only examine the Witness on a few points, and the others would be taken in detail from subsequent witnesses.

The WITNESS declared that as to practical construction as contrasted with theory, in his opinion, neither Deprez's publication nor Ayrton and Perry's publication would have enabled a person to make a useful meter. Ayrton and Perry had not, within his knowledge, made a meter at the time of Witness's publication.

How many years was it before they succeeded?—One of them, Prof. Perry, made a meter, I think, in 1890.

WITNESS said that in the same year he took out a specification for an energy motor, but that was before the publication of his first specification. The two were concurrent, and were at the same time in the Patent Office.

In regard to the infringing meter, was it an infringement inasmuch as the current passing through the armature is with a constant potential?—Yes. There was a shunt coil in the field. A little current ran through that, quite independent of the lamp circuit.

So there is a complete motor apart from the lamp circuit?—Certainly.

If, said the WITNESS, in order to get enough contact so as to have no resistance at the commutator brush, you had excessive pressure, that gave friction. It was so important to get good contact, that it had to be sought, even though it gave friction. He could not see that it made any difference whether the "pole-pieces" were cast in one or joined on. His original meter was a practical meter in its time, and not surpassed in accuracy by any motor meter, though surpassed by the Edison deposit meter, and possibly by the Aron meter, which worked by clockwork, but not by any self-contained meter.

Mr. JAMES SWINBURNE, examined by Mr. WALTER, was the next witness. He said the importance of meters was fully realised long before 1887, though actual demands for instruments were small. As early as 1884 inventors were endeavouring to find a meter. The essential requirements of a meter were that it would measure electric energy, or in practice the electric current; it must have a proper range, and, of course, be accurate throughout that range. It was useless having a meter which was useful for 10 lamps but useless beyond 12 lamps, and the meter must start with one lamp. In those days there was difficulty in getting a meter which would start with one lamp when there was a large installation. It often happened that a householder constantly burnt one or two lamps in a dark passage or apartment, and the revenue from those one or two lamps was of even greater importance than from the number of lamps used a very short time. As regards the use of magnets, he knew of no one before Hookham who designed permanent strong magnets, although fairly strong and fairly permanent magnets might have been found in various places. Hookham's use of mercury he thought was new. Mr. Hookham was right in pointing out the advantage of having a constant field, and if he might respectfully say so, took a very intelligent means of carrying it out.

Do you know what meters were, in fact, in existence at the date of Hookham's specification?—Ferranti I remember working at his meter from 1884 onwards. I do not know whether the Ayrton meter was at work at this time. I do not think there was any meter in actual use.

There was the Edison deposit meter?—That, said the WITNESS, was not in use in this country, though in extensive use in the United States. The Ferranti meter was not of the Hookham type at all. The motor part should have followed the square law, and the brake part of it ought to have followed the square law, but neither followed any law accurately. Ferranti's meter had a fairly good range. It worked on entirely different lines to Hookham's meter.

The WITNESS was taken *seriatim* through the specifications prior to Hookham's. Munro employed a Barlow's wheel. There was nothing in his paper to show that he knew anything about the action of a brake. Munro, in his opinion, did not teach anything as regards the operation of a meter, and would not enable a person to produce a practical meter. Ayrton and Perry pointed out the use for a meter of a motor, and their specification gave a full explanation of the theory of what he would call a straight-line meter, but it did not carry the matter beyond theory.

I think we learnt from the patentees in the witness-box at the last trial that they had not produced a practical meter?—We did hear something of the kind, I believe.

In your view, would this enable anyone to make a practical meter on the lines laid down?—I do not think it is necessary to go into hypothesis at all; it did not. There is not enough disclosed.

As regards Handford's specification, WITNESS said he found no instructions given respecting the saturation of the magnets. It taught the manufacturer of a meter nothing. Abel's specification was not for an ampere-hour meter, but was a meter recording the flow of current at any particular moment. This gave no indication as to the strong magnetisation of the magnet. Yeatman's specification of 1885 concerned the motor only, and not the brake, and told nothing about the brake. It did not teach the world how to manufacture a meter that would mete. Weston had got the field magnets. It did not teach Hookham's invention; of course it went in that direction, but, in fact, the knowledge was not Weston's. It was common knowledge at that date that saturated field magnets could be used as instruments, Weston in his other specification of 1885 might have had a pious wish to obtain an ampere-hour meter, but it did not work. The apparatus would not work at all unless it had a very considerable current passing. As regards meter construction, it contained nothing to lead anyone to a successful meter.

Constancy of field had been used in measuring instruments before, but not in meters?—Yes.

WITNESS said Siemens had suggested for the purpose of a brake a device of fluid friction. Deprez gave to the world nothing more as to the constructional part than Ayrton and Perry, and no direction as to how the strength and permanence of the magnets should be obtained. Deprez did not disclose plaintiffs' invention. There was nothing to be learnt from Handford and Siemens with reference to powerful constant magnets. In his opinion the researches of Jamin did not disclose the Hookham invention. He also thought that Dredge's specification did not disclose Hookham's invention. He was acquainted with the meter used at Bradford. The motor was a straight-line motor, and the brake a straight-line brake—permanent magnets from permanent magnets. It followed the straight-line law, and gave strength and constancy to the field. That followed in his view the instruction indicated by Mr. Hookham. At Bradford there was a constant pressure supply. Upon the mains used at Bradford the character of the field would be constant and the little auxiliary force would be constant. The meter could not work properly without a constant field. The meter in use at Bradford measured ampere-hours.

At the conclusion of hearing of the witness's evidence-in-chief, the further hearing was adjourned till Thursday.

THURSDAY, MAY 10TH.

MR. JAMES SWINBURNE, cross-examined by Mr. CRIPPS, said that the plaintiffs' machine consisted of two parts, the motor and the brake.

You say as to the motor the substantial difficulty at the time was practically the question of friction?—I thought that was so.

Now, as regards getting rid of friction, do you suggest that the defendants took anything at all from plaintiffs' specification?—No; I think the defendants got round the difficulty in another way. Well, that brings me to the brake. You say it has to be constant?—Yes.

I suppose by constancy there you refer to the mains?—Yes.

"Constancy," of course, can be retained in a magnet in different ways?—Yes.

It can be obtained if you use proper steel by artificial ageing?—Yes.

That was known before Mr. Hookham's specification?—Yes.

Therefore, if anyone obtained constancy in a magnet by artificial ageing, that would not be infringement or interference with the plaintiffs' specification?—No, I think not.

Now, I think the other point with regard to the magnet was to get it strong?—Yes.

Supposing you had a magnet made constant by artificial ageing, and used two or three weaker magnets instead of one powerful magnet, would you say that would be interference with the plaintiffs' specification?—That would be a question of degree.

It is a question of degree?—Yes.

I suppose you are aware that the defendants formerly used three magnets, and now used two?—Yes.

Do you say that after the plaintiff brought out his specification, that in future any other person would be prevented from using a magnet such as that (handed in).

The WITNESS: Yes, I think he would for the purpose of using it on a brake of this sort. I think he would be prevented from using a strong constant magnet on the disc brake of the meter.

So far as power is concerned, do you really say that after the plaintiffs' specification, no one is to use the common form of horse-shoe magnet?—Well, it is very difficult to say. The witness added that there was a distinction in knowing how to do a thing, and knowing how to do it without infringing.

I will put aside the question of artificial ageing for the present. Take the form of magnet you have in your hand, It is nothing more than an ordinary horse-shoe magnet. Do you say that magnets of that kind are not to be used after the plaintiffs' specification?—That was a very broad question. Magnets like that had been used before the plaintiffs' specification, but not used on a meter. The question of ageing might be hypothetical.

Well, anyone using a permanent magnet of that form and shape. Do you say that no one could use a magnet of that form and shape after the plaintiffs' specification for any purpose?—That, of course, could be used for some purposes.

It was a known form of magnet?—The WITNESS assented, and said there were lots and lots of magnets used.

In reply to a question put by his LORDSHIP the previous day, the WITNESS handed up the Electric Lighting Act, which he pointed out laid down that the variation of pressure in any consumer's terminal should not exceed 4 per cent. from the declared constant pressure.

In further cross-examination, the WITNESS said that the ageing of magnets to produce constancy was well known. In a report of Hookham's meter, made about 1892, he said, talking of the magnets, that "the field is made up of a bundle of bars of steel of a special character, properly hardened, with cast-iron pole-pieces." That was an accurate description of Hookham's magnets.

That would not be in any sense a description of the magnets which defendants use?—No. They use no cast-iron pole-pieces.

Nor is there a bundle of bars of steel of a special character?—No, I believe there was a bar only.

Mr. MOULTON pointed out that the meter upon which that report was made could not be the one in the specification.

It was the case, said the WITNESS, that where magnetic circuit was closed you had constancy and permanency, and the nearer you got to it, the smaller the extent to which you had broken the circuit, the

greater would be the permanency and constancy. In Siemens there was a brake by a fan revolving in a liquid. As regards the motor, Siemens's and Hookham's system was practically the same. Marcel Deprez suggested the use of a copper disc revolving between the limbs of a permanent magnet.

All that defendants have done in modification of Siemens is to attach a copper disc revolving between the limbs of a permanent magnet?—Quite right.

And the cause of it, I think, was correctly stated below?—Yes.

Do you say after that statement by Marcel Deprez that the defendants ought to be prevented, in connection with a meter like Siemens, from introducing a copper disc revolving between the limbs of a permanent magnet?—It depends whether you use Hookham's invention in so doing.

What is there to prevent the defendants from taking what Siemens and Deprez tells them in the year 1884?—There is nothing.

Mr. Justice FARWELL: For my information tell me, if you had had that put before you in 1884, could you have made a meter?—I do not know if I could have made a satisfactory thing. I might have gone in that direction, and might have discovered how to make a permanent magnet. The result of following those directions would be that you would have a thing with insufficient brake power.

Why? You can get a constant magnet by artificially ageing it. Do you mean to say there would be any objection to putting on three or four magnets if one was not strong enough?—No. I think you could stick on a good many magnets, but I doubt if you could get on enough unless you knew how to make this special magnet.

Do you say that (defendants') magnet is aged or made according to anything in Hookham's specification?—No; I conclude from its working so efficiently, that it is made from Hookham's specification.

Mr. CRIPPS: Your Lordship will hear evidence on that point. (To witness): If I get a magnet perfectly perfect by ageing, what will you say to that?—I should say you had better use it on your meters.

In continued cross-examination, WITNESS said Deprez's references on this point were to his magnetic speed indicator. Abel's magnet and the defendants' magnet were practically the same shape. If four of Abel's magnets were attached side by side it would be practically the same thing; there might, perhaps, be a little more permanency and power in Abel's.

An instrument was handed to witness which was described as following Siemens for the motor, with a copper disc for the brake according to M. Deprez, and a form of magnet found in Deprez's figure of a speed indicator. Witness said he had little doubt it would work perfectly as an energy meter. How accurate it would be, and how long it would work accurately, he did not know.

I put it to you, supposing we follow what was pointed out by Siemens and Deprez years before Hookham, you do not suggest that we are not entitled to do that?—That is a matter of law.

Mr. Justice FARWELL: Is there any practical reason why an instrument made according to these anterior suggestions should not work?

Mr. CRIPPS: It does work.

Mr. Justice FARWELL: That he does not know.

WITNESS: This, I think, would certainly work as a meter now. Whether the magnet would be permanent I do not know without trial. If this meter had been brought out in 1887, I think you could have sold it.

Mr. CRIPPS: But the question of constancy or permanency is dealt with by ageing the magnets. Supposing you found one aged magnet was not sufficient, why not put on two or three?—If you put six aged magnets on, I should think it was quite possible it would work commercially. If a magnet was going to change, it generally rapidly developed.

An ammeter of Ayrton and Perry's was handed up, which was stated to have been constructed about 18 years. In a measuring instrument of amperes, the WITNESS agreed they had in this exhibit what was a constant magnet in the sense that it had not varied for 18 years.

You can hardly get a more apt illustration of prior user, as regards what either plaintiffs or defendants had done?—As regards constancy it is very good.

As regards power, if one magnet is not sufficient, why not put on four?—You can use as many as you like.

The WITNESS did not agree that a constant field, produced according to Hookham's specification, could not be used in connection with the measuring of alternating currents. It would not, however, be a good practical arrangement.

Has it ever been done?—Not so far as I know.

Questioned as to Handford's specification, the WITNESS stated that they had there described a constant field produced by permanent steel magnets.

Do you in Handford's get a motor working in a constant field?—Yes.

The WITNESS, further cross-examined, said that the method of producing a constant field by saturation was known before the plaintiffs' patent. It was known in measuring instruments, and was shown in Weston's in connection with the meter.

Re-examined by Mr. MOULTON: There are in this book collections of prior specifications and references to bits of electrical papers. I suppose I may take it that there were many thousands of specifications relating to electrical measuring instruments before 1887?—Oh, yes.

And I suppose I may also take it that there were many thousands of papers relating to magnets and magnetism before that?—Yes.

The WITNESS explained that when one knew how to do a thing it was not difficult to look up literature and pick here and there and put things together and show how to make it, but in many cases to do that thoroughly was difficult.

Mr. MOULTON: I may take it that at that time there were hundreds of forms of magnets used?—Yes, I think you could get any form of magnet you wanted.

Re-examination continued: Since the plaintiffs' specification it was known that power and permanence were not mutually exclusive.

Taking a permanent magnet such as Mr. Hookham referred to. That was perfectly constant and very powerful?—I think so.

In instruments that existed before the date of this specification, constancy was sufficient without power, and power without constancy. Was there anything before the date of this specification which communicated the union of the two?—Not that I can think of.

In the case of a meter if you did not have constancy, it failed of its purpose?—That strength was important for accuracy in a meter. Meters had very peculiar requirements.

Prior to the Hookham specification, do you know of anything which published to the world the way to get permanent magnets constant and strong?—No, I think the electrical world is indebted to Mr. Hookham for the way to make strong permanent magnets. The witness added that in order to make this type of meter which was theoretically known a practical one, that was one of the things wanted. There was nothing in the d'Arsonval galvanometer which would tell the world how to make an effective meter. Too much strength was a disadvantage there, and weak magnets were used—quite weak.

The WITNESS, questioned as to the Siemens specification, said that Siemens was trying to obtain magneto currents for telegraphic work, and constancy was not in the least necessary for him for that purpose. In Siemens instrument the paraffin or liquid was intended to fill the whole apparatus. That would not be a practical or accurate measuring instrument. Viscosity of the liquid would vary with temperature. M. Deprez did not convert Siemens to his brake. Prior to Hookham, he found no suggestion that his type of magnet should be selected for the purposes of a magnetic drag. Weston was a well-known electrician who devoted a great deal of attention to measuring instruments. His meter, so styled, was a wholly impractical instrument. In Abel, the active part consisted of two little pole-pieces embracing the mercury. In Jamin, again, the active part was the ends, not the sides. A practical meter must start, if possible, with one lamp. In order to improve the speed indicator, Deprez gave a suggestion that would make it impracticable for the use of a meter. Plaintiffs' meter was mainly described in the specification for direct currents, but it was indicated that it could be used for alternating purposes. Defendants' meter would also work with alternating currents. The principle of Hookham's meter was that it was made on the straight-line law with a brake following the straight-line law. Weston's (No. 2) meter would not measure anything. As to the commutator, if constructed as Hookham described it, it was an instrument for accurate work.

Mr. CRIPPS: If you artificially age a magnet, would you lose in power more than 15 per cent.?—It depends how much you age it. It may be you would not.

Mr. DUGALD CLERK, examined by M. A. J. WALTER, said he was of opinion that Mr. Hookham's invention was the first practical meter which showed a simple mode of motor and a simple mode of brake. That was to say, a motor in which the twisting power was proportionate to the current, and in which the resistance of the brake was proportional to the speed of rotation of the brake. He found for the first time a magnetic brake working in such a way as to give a powerful field as well as a constant field. In obtaining a practical meter to start with one lamp it was necessary to have a strong field. That was pointed out by Hookham in his specification. The constancy of the brake was also important, and that the brake should have a long range. He had visited Bradford, and in company with the chief engineer to the Bradford Corporation, examined the system of electrical distribution.

What practically is the condition of the potential in the main at Bradford?—They work at 230 volts nominal potential in the main, and the variation, from what I saw, does not exceed 2 per cent. I also examined the meter used in the Bradford circuits.

Is there in that meter any device for the purpose of starting the meter?—Yes, there is a separate small coil.

And the device pointed out by Hookham in his specification, the winding round the magnets or armature for the purpose of starting?—Yes.

In further examination, the WITNESS said he had read through all the specifications introduced into this case, none of which, in his opinion, disclosed to the world the inventions contained in Hookham's specification. Siemens' suggestions for a motor meter contained no provisions for eliminating the friction. In Deprez he found no indication of the importance of (1) a powerful field; (2) a constant field for the brake; (3) strong field for the brake; (4) provisions against friction.

Are those conditions which you do not find in Deprez's paper of importance or not in the construction of a practical meter?—Of great importance.

In respect of claim 3, witness found an infringement of the plaintiffs' invention in the use of large pole-pieces closely approaching each other. In your view of the plaintiffs' specification, looking at it as an engineer, do you see any emphasis placed on "independent pole-pieces?"—The "poles" described in the specification were additional poles, and were shown in the drawings as additional poles, but in that there was no limitation as to the poles being attached separately. This was a simple and convenient method of making them.

Cross-examination continued: Ayrton and Perry failed in showing any practical details to enable any person to make an electricity meter. It did not enable them to make them. One of the great advantages of Hookham's specification was the making the frictional force very small compared with other forces. Everybody agreed that that was what was wanted, but none of them could do it. Hookham

did it by making a very powerful magnet and a very powerful brake, and thus reduced his friction. A powerful brake diminished the friction. Hookham made his magnet powerful, he supposed, by sending a large current round the wires which magnetised his magnets. There was nothing new in that. It was well known how to make a magnet powerful.

Mr. GRAHAM: How do you say Hookham obtains constancy?—He makes it constant by having large pole-pieces closely fronting each other, and by this method of large pole-pieces and close fronting, he completes his magnetic circuit and keeps it constant.

Had that not been pointed out before the date of Hookham's patent?—Not that I am aware of.

Mr. MOULTON said he had Prof. Boys in Court, but after the three witnesses he had already called he did not wish to unnecessarily increase the bulk of the evidence. His learned friend would also perhaps be satisfied with three witnesses.

Mr. CHIPPS said he could give no undertaking. He might call four, or might be satisfied with one.

Mr. WALTER then read the *verbatim* report of the judgment of Mr. Justice Wills in the action tried in the Queen's Bench Division, Chambers & Hookham *v.* Johnson & Phillips, delivered some three years ago, when the learned judge upheld the validity of the plaintiffs' patent.

That closed the plaintiffs' case.

Mr. CHIPPS said he would not address the Court at any great length at this stage, but would reserve himself until after he had called his witnesses. One or two points, however, it was desirable he should deal with. As regards the judgment of Mr. Justice Wills in Chamberlain & Hookham *v.* Johnson & Phillips, there the conditions and circumstances were entirely different from those in this case, and the specific issues raised in that action were totally distinct from the issues raised in this action. Although it might be necessary in a certain event hereafter to raise the question of validity of plaintiffs' patent by reason of anticipation, he could not now ask his Lordship to disagree with his Lordship's finding. But when new anticipations were brought before his Lordship which were not before Mr. Justice Wills, that was not entirely a question of construction, but a new issue with which his Lordship could deal. The learned counsel said he had very great difficulty in following Mr. Moulton in what he called the litigious points, viz., the points in issue. He thought he might say that his learned friend did not seek to grapple with what were the difficulties he had to contend with, but he supposed he would deal with them when he came to reply. He would first deal with the five points which Mr. Swinburne had laid down. Mr. Swinburne said first of all that the Chamberlain & Hookham specification and patent was only for measuring current. It was, in the first place, impossible to say that a combination—more particularly when they knew of the principles, and all the principles were old—which led to the making of a machine for the measurement of current was an anticipation, even if you used the same principles in making a machine for measuring energy. It was impossible to patent a principle in the English law. It was undoubtedly law that if anyone took those same old principles and placed them in a different way and produced a different result, he was not infringing, and that was the defendants' case. The merit of the defendants' machine, and the use made of it, was that it measured energy. He could not see the weight of his learned friend's argument upon that part of the case. You had to compare machine with machine, and if anyone liked to use a particular machine under conditions in which one of the factors was the same, that did not matter. The defendants' machine was a machine which measured energy. It was a machine which was different in its results, and was arrived at by an entirely different combination to what was found in the plaintiffs' specification. The defendants' combination was absolutely different, and distinct from the plaintiffs, and aimed at a different object. On the next point Mr. Swinburne said that the meters of Messrs. Chamberlain & Hookham consisted of two parts, viz., the motor and the brake. That was perfectly true. Again Mr. Swinburne said both as regards the motor and brake Chamberlain & Hookham followed the correct law. That was also true. Mr. Swinburne then came to the motor part of the invention, and said that the merit of the invention was so far as it got rid of friction. Ayrton and Perry in their energy meter did not manage to get rid of friction, and so did not arrive at practical results. Chamberlain and Hookham did, but how did they get it? Mr. Hookham had explained that in evidence. Defendants used not one of those methods adopted by the plaintiffs. In Hookham's machine were a constant field and particular methods of getting rid of friction. Up to this point, he submitted, there could be no infringement. So far as defendants were concerned, a constant field was destructive. A third point remained, that of the brake, which had to be constant and effective. The two matters to which Chamberlain & Hookham directed their attention were constancy and power. They described a particular form of magnet. Application of a magnet to a brake was not suggested to be new. What was new was the particular way in which plaintiffs arrived at a magnet which was constant and effective. That was only one part of the combination; but what the defendants did was not at all in contradiction of any claim made by Chamberlain & Hookham's specification at all. What defendants did was this—they got a magnet made of steel of special form, and then artificially aged it in order to make it constant. That was common knowledge at the time, and there was nothing of it in Chamberlain & Hookham. This process of artificially ageing the magnet reduced its power by something like 15 per cent. So far there was no suggestion of contravention of plaintiffs' claims. It was said by plaintiffs that they showed the way of making magnets, both constant and powerful. What was the answer to that. Defendants' magnet followed the horse-shoe form familiar to any schoolboy, somewhat modified, no doubt. As regards strength and separation of the poles, it was merely a matter of degree. They made it permanent by artificially ageing it. It was said that there was difficulty in getting a magnet both powerful and constant. That had not, in fact, been a difficulty as regards the defendants. For power, at one time they had used three magnets; now they used two. The form of their magnet entirely differed from plaintiffs'. It was obvious that so far as the magnet was concerned there could in no sense be said to be infringement, because supposing they took the poles a little nearer, or used five or six magnets to get the proper power, it was only a question of degree—nothing new. In the same way it was well known that you could apply a permanent magnet to a copper disc in order to get great power. It could not be claimed by Chamberlain & Hookham that they first of all invented a brake power by applying a permanent magnet to a copper disc. They did not say that, but were obliged to limit themselves to a particular form of magnet, and say, "We were first to point out that you get permanency and power by that particular form." They would lose at once if they went beyond that. Although there was a mention of alternating currents by plaintiffs, there was no suggestion of applying the Hookham meter to alternating currents. No less a proportion than 90 per cent. of defendants' meters were used for alternating currents. Defendants' meter was the practical meter of every day life, in use all over the world, and there were thousands of them at this day employed in England.

At this stage the Court rose for the day.

The hearing was continued day by day until Wednesday, May 16th, when counsel having summed up, Mr. Justice Farwell reserved judgment.

(*To be continued.*)

BULSTRODE & Co. *v.* JULIUS SAX & Co., LIMITED.

IN the Queen's Bench Division of the High Court of Justice on Friday (May 11th) before the Lord Chief Justice and a special jury. This was an action by Edward Bulstrode, Thomas Wilson, Emil Buhler, William Krause, and John Plumb (carrying on partnership under the style of the Saxon Electrical Engineering Company, Gervase Works, Gervase Street, Old Kent Road) to recover damages from Julius Sax & Co., Limited, for libel. The defendants admitted the publication of the libel, but denied the innuendoes which the plaintiffs said must be drawn from it. Under these circumstances, the only question for the jury was as to the amount of damages.

Mr. Rawlinson, Q.C., and Mr. J. W. McCarthy, instructed by Henry F. Kite, appeared for the plaintiffs; Mr. Rufus Isaacs, Q.C., and Mr. Macaskie, instructed by Francis & Johnson, appeared for the defendants.

Mr. RAWLINSON, Q.C., said that the five plaintiffs were previously to July of last year in the employment of a company, called at one time, Julius Sax & Co. and afterwards Julius Sax & Co., Limited. Mr. Bulstrode had been in the employment of that company for 20 years, and the other four plaintiffs also had positions in the old firm. Towards July of last year it became clear that the old company would not be able to continue their business for long, and at the beginning of August the plaintiffs made up their minds that in case anything happened to the old firm they would set up on their own account as electrical engineers.

The LORD CHIEF JUSTICE: Do you mean that the old company was in difficulties?

Mr. RAWLINSON said that was so. What happened was that the old company sold their business to a Mr. Salmony, who practically had to form a new company, which took over the business of the old Julius Sax & Co. In the beginning of August Mr. Salmony, who was in negotiation for the purchase of the business, approached the plaintiffs with a view of their staying on in his employment, but these negotiations fell through, and on August 12th the plaintiffs gave notice to leave the old company. Upon August 19th, their notice having expired, the company put up a notice saying they had gone into voluntary liquidation, and all the employés of the company might consider themselves not required. The plaintiffs then sent from the Gervase works the following circular to various persons they knew in business:—

September 4th, 1899.

The firm of Julius Sax & Co., Limited, having gone into voluntary liquidation, we, the undersigned, being the heads of the various departments named below, have formed ourselves into a syndicate to carry on the business of electrical engineers and electric light contractors at the above address, assisted by several of the late employés of the old company, working on the lines of the old firm, manufacturing the best articles, and putting in first-class work only. Trusting for a share of your support, which shall receive our best attention,

We remain, yours faithfully,
(Signed by the Plaintiffs.)

On September 7th, the defendants published the following circular letter, which was the libel complained of:—

119, Coldharbour Lane, Camberwell.

Dear Sir,—It has come to our knowledge that certain former employés of the firm who were discharged by us, have sent out to our customers a circular containing misleading statements, which may possibly be injurious.

The matter has been placed in the hands of our solicitors, who will take steps to put an effective stop to such statements.

The firm of Julius Sax & Co., which has been established for 50 years, was recently reconstructed with a view of introducing additional working capital, and more vigorously prosecuting the business.

The business will be carried on precisely as heretofore at the above address, by a thoroughly competent staff, and under the guidance of well-known electricians, while at the same time the services of such of the former staff who have proved themselves capable and competent have been retained.

In order to prevent servants whose services we have not thought it right, in the interests of the company, to retain, from prejudicing our customers, we think it only necessary to call your attention to the above facts.

Yours faithfully,
JULIUS SAX & Co., LTD.

On behalf of the plaintiffs, he (Mr. Rawlinson) submitted that that circular suggested that the plaintiffs were discharged, that they had made misleading statements, and that they were incompetent, and that the defendants did not think it right in the interests of the company to retain their services. The plaintiffs, through their solicitor, asked for an apology, but none being forthcoming, and the letter being republished in the *Building News*, this action was brought.

In support of the case for the plaintiffs, evidence was given by Mr. Ed. Bulstrode, who said that the business of the old firm of Julius Sax & Co. had not paid for two or three years before he and his co-plaintiffs left. His impression then was that the old company would not carry on business. The plaintiffs had been doing fairly well.

Mr. Wilson and Mr. Krause, two other plaintiffs, also gave evidence.

Evidence was then given for the defence.

Mr. Salmony said that he negotiated for buying the business of the old firm, and ultimately did so by an agreement of July 27th. He resold it on August 24th, and it was still carried on as Julius Sax and Co., Limited. He had had many consultations with Mr. Bulstrode about purchasing the business, and told him he was going to form a company to take over the business and carry it on just as it was before. He told him that several times, and everybody in the place knew it. He had an interview with Mr. Bulstrode about his staying on, but they could not come to terms.

In cross-examination, Witness was asked as to why he did not withdraw and apologise for what had been stated, and he said that he left the matter in the hands of his solicitors who advised him. He did not know how the letter got into the *Building News*.

Evidence was also given by Mr. Abbuthnot, the managing director of the defendant company.

Mr. Rufus Isaacs, Q.C., said the plaintiff Bulstrode had no possible justification for using the list of the defendants' customers in sending out the circulars. The retort of the defendants was, under the circumstances, perfectly reasonable, simply because he had imputed in his circular what was not the fact, namely, that the company was defunct. Again, the name of the plaintiffs' company was extremely similar to that of the defendant company, and he thought that Mr. Bulstrode had some idea that, by means of his circular, he was going to get the benefit of Julius Sax & Co.'s business. This was a war of circulars, and while the defendants had sent out a circular which could not be justified, he submitted the plaintiffs had done exactly the same thing.

Mr. Rawlinson said there was no evidence of this imputation about the list of customers or similarity of name, and if the plaintiffs had done the defendants any wrong in those regards, the defendants could bring an action against them now and recover damages. It was open to the defendants to have counterclaimed in their action in respect of these matters, but as that had not been done the jury had nothing to do with them. He reminded the jury that the libel was admitted, and that it was impossible to calculate the amount of damage it might have done to a young firm just starting in business.

The Lord Chief Justice summed up, and pointed out that the defendants could bring an action now if they had any complaint about the suggestions as to the list of customers and similarity of name, therefore the jury must not take these matters into consideration.

The jury returned a verdict for the plaintiffs for £250, which they said was £50 for each of the plaintiffs.

Judgment was entered accordingly, and it transpired the defendants had paid £10 into Court as sufficient to meet the plaintiffs' claim, which amount was ordered to be paid out to the plaintiffs.

Knowles *v.* Isle of Man Tramway Company.

In the Douglas High Court on Thursday last week Mr. Gelling moved for a commission to examine Mr. Alex. Bruce, chairman of directors of the Tramway Company, in the matter of a suit brought by Mr. W. L. Knowles, engineer, against the Tramway Company, in respect of a sum due for services in connection with the construction of the Laxey and Ramsey section. The commission was granted.

The Castner-Kellner Alkali Company *v.* The Commercial Development Corporation.

In the House of Lords on Monday, before the Lord Chancellor, Lords Macnaghten, Morris, Shand, and Brampton, the appeal of the Castner-Kellner Alkali Company *v.* The Commercial Development Corporation, Limited, of Liverpool, came on for hearing. The appeal is from an order of the Court of Appeal discharging a judgment of Mr. Justice Bigham in an action wherein the appellants were plaintiffs and the respondents defendants. The action was brought for the purpose of obtaining an injunction to restrain the respondents from infringing the patent of Carl Kellner for an invention, "Improvements in Electrolytic Apparatus for Decomposing Metallic Salts," and for the delivery up of all infringing apparatus. For the purpose of enabling the appellants to bring an action to determine the question of infringment to which the action relates, the respondents admitted that they were intending to use an apparatus similar to that described in the letters patent granted to Rhodin, and the action was brought to restrain the use of such apparatus, which the appellants contend is an infringement of Kellner's. The respondents denied infringement and alleged that the letters patent were invalid. Mr. Justice Bigham found that the letters patent were valid, and that the respondents had infringed them, and he granted a perpetual injunction together with an order for the delivery up of the infringing apparatus. The Court of Appeal (Mr. Justice Vaughan Williams dissenting) discharged the judgment of Mr. Justice Bigham. The invention, which was the subject of Kellner's patent, relates to apparatus for the manufacture of caustic soda by passing a current of electricity through a solution of common salt (chloride of sodium) in water, which has the effect of liberating chlorine at the anode and sodium at the cathode. In such apparatus it was known that if the cathode was a layer of mercury the sodium would enter into combination with the mercury, forming a fluid amalgam of mercury and sodium, and that this amalgam might be subsequently decomposed by the action of water into mercury and caustic soda. Various forms of apparatus for electrically effecting the decomposition of the salt solution with a mercury cathode, and the subsequent decomposition of the amalgam in the above manner, the appellants said had been published before the date of Kellner's letters patent. It was contended by the respondents and found by the Master of the Rolls that by the words "stationary mercury cathode" used in Kellner's provisional specification, the patentee meant a mercury cathode which was stationary with respect to surrounding objects, and that as the mercury used in the apparatus and claimed in Kellner's specification was situated in a rotating vessel, this apparatus so described and claimed was such a departure from the invention disclosed in Kellner's provisional specification as to render the letters patent invalid.

Mr. Fletcher Moulton, Q.C., in stating the appellants' case, said the appeal arose over the question of the infringement of patents. The old processes of producing soda were merely chemical, but now it was produced to a very large extent by electrical decomposition in salts. The method of producing it by electrical decomposition, was by passing a current through a solution of salts, whereby they got soda in solution. The chlorine went off, the hydrogen went off, and the oxygen was taken up by the soda. The disadvantage of these processes was that they never got the soda pure, because the soda was in solution with salt, and although they might crystallise it they always got a mixture which it was difficult to separate. Many people had tried to follow a method which was very ingenious, and which had been tried before the patent, which was the chief patent, which would have to be discussed. The learned counsel then proceeded to describe the electrical processes by which the chlorine would escape and the sodium would be deposited in the mercury exactly in the same way as in silver plating, pointing out that none of these processes were successful on account of the trouble of removing the charged mercury, putting it into another vessel, and then making it discharge itself of the sodium. None of the processes were practical until they came to the patent of which he should have to refer—that of a man named Castner. He introduced a continuous process by introducing two new steps. He took a cell and separated it by a partition passing down almost to the bottom, and then he poured in mercury until by coming up to the bottom of the partition it made a seal between the two parts. He filled up one part with salt water and the other with pure water, and passed a current through the salt into the mercury at the bottom, and from it to the other partition up through the water and out again. Thus, physically, there were two chambers, but electrically they were united, because the mercury, being a very good conductor, the current passed from the one to the other, and the sodium went into the mercury at the bottom.

The Lord Chancellor: That is the same mechanical process as you have described.

Mr. Fletcher Moulton said that was so, but under this patent the current agitated the mercury at the bottom, so that having got the vessel charged on the right hand side it passed into the left hand side, and then the current repassed through it, accelerating enormously the discharge. The point of the Castner invention was that he covered the whole of the bottom of the cell with mercury which was agitated from one division to the other, the consequence being that the mercury got charged in the right hand division and in the left hand division it discharged. This process was now very largely used with some modification. He came now to the patent on which the action was founded, the patent of Kellner, who had the same idea of using mercury in the same way.

The Lord Chancellor: What is the ground of the decision against you?

Mr. Fletcher Moulton said it was practically disconformity—that the complete specification went too far. That was the only point which had been given against them by the majority of the judges.

Lord Shand: That your full specification went much further than your provisional?

Mr. Fletcher Moulton said that was so; Kellner's patent still existed. Kellner's idea was to take the cell and place it in a larger vessel with mercury at the bottom so that it sealed the cell, and then he moved the cell to and fro.

The Lord Chancellor: The chemical process was the same, but the mechanical process by which the charging and discharging was effected was different.

Mr. Fletcher Moulton said it was a new mechanical arrangement. Kellner was the first to use the mercury as a cathode and anode. The learned counsel then explained how the respondents, as they had announced their intention of doing what the appellants contended would be an infringement of these patents, gave a formal acknowledgment of what they proposed to do, and to settle the point, an action was then brought by the appellants to restrain them from so acting. The action had thus been brought before infringement. The appellants possessed the Castner, the Kellner, and a number of other patents. The respondents say they meant to use the Rhodin patent which was later than the others. The difficulty which would arise as to the Rhodin patent was, that while the appellants in their provisional specification spoke of moving the cell to and fro, later it was said its movement might be rotary, and they claimed both these forms. His contention was that there was no difference between the Kellner and the Rhodin patents, except that Rhodin took the alternative which the appellants put in their complete specification, by making the movement round and round instead of to and fro.

The Lord Chancellor: The chemical agency is common to both, and you do not claim it in this action. Thus it comes to me—chemical arrangement by which the chemical qualities of these various substances may be properly developed. As I understand, in your specification you have only described to and fro movement.

Mr. Fletcher Moulton: In the provisional specification.

The Lord Chancellor: They on the other side say we do not move to and fro. That is the only distinction between you.

Mr. Fletcher Moulton: That is so. But I shall put before your Lordship that our real intention——

The Lord Chancellor: I understand it comes to this—never mind whether your patent is good in itself or not—that your specification is too wide, and that therefore your patent is bad. That is really what we are discussing.

Lord Shand: In your provisional you talk of the motion to and fro. In your final specification you speak of the rotary motion, and it has been held that one does not cover the other.

Mr. Fletcher Moulton: But of course you have to consider that although only the to and fro motion is spoken of in the provisional, we were the first persons to use the motion of the cell at all.

The Lord Chancellor: Your patent is for the mechanical arrangement, and if that is described in your provisional specification so as to exclude the circular motion, it seems to me you will have difficulty in showing that you can cover that by your complete specification, and so introduce the new element of circular motion.

Mr. Fletcher Moulton said he quite agreed, but on the question of the rotary motion there had been no decision against his clients. In the provisional specification the invention was described in a very broad and general way. It set forth: "This invention has reference to an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode, in which the amalgam formed by electrolytic action has its location changed from the decomposing chamber in which it is produced to a combining chamber in which it is decomposed and the cation combined with water, an acid, or other body, by the shifting of a partition which is adapted to be moved to and fro in the mercury and serves to separate the two aforesaid chambers from each other." That, said learned counsel, described the real invention. The point of the invention was the moving of the bell over the mercury. The specification proceeded: "The partition is, in this case, made in the form of a bell closed at its lower edge by a mercury seal and enclosing the decomposing chamber so that the amalgam formed in the latter is caused by the shifting of the bell to have its location alternately on one side and on the other side of the bell without itself changing or moving its position, and thus is caused to gain access to, and become situated in a combining chamber, effects the amalgamation of the metal that is being separated by electrolytic decomposition of the electrolytic. In this way a considerable output can be obtained from the apparatus with a comparatively small quantity of mercury, because both operations can take place simultaneously and uninterruptedly."

The Lord Chancellor said it seemed to him that the complete specification contradicted the preliminary specification, because the whole theory of one was a motion across, and the other a motion round.

Mr. Fletcher Moulton maintained that here there was something deeper and more general than a mere question of mode of movement. Whether the motion was rotary or across, it was the same thing done in the same way.

The case had not concluded when their Lordships adjourned.

(To be continued.)

Dobell *v.* Marshall and Another.

Mr. Justice Lawrance, sitting with a special jury in the Queen's Bench Division on Tuesday, heard this case, which was a claim for £90 for arrears of salary from June 9th to October 13th, 1899, and also damages for wrongful dismissal.

Mr. Rufus Isaacs, Q.C., and Mr. Willoughby Williams appeared for the plaintiff, and Mr. Tindal Atkinson, Q.C., and Mr. Drake for the defendants, who were Messrs. Cooper & Marshall, of Victoria Street, Westminster.

It appeared that the plaintiff, an electrical engineer, was interested in some patents for obtaining electric energy direct from coal. He assigned patents to the defendants, in whose employment he had been for some years, and a syndicate was formed, and plaintiff was paid £5 a week, and employed his time in experimenting with a view to bringing the invention to perfection. The experiments, however, were interrupted by reason of lack of funds, and between the dates mentioned the plaintiff received no salary. In October more money was obtained, and a fresh arrangement was made by which the plaintiff was to receive a salary of £7 a week and 5,000 shares in a syndicate or company to be formed. He proceeded with the experiments until the end of October, when he was sent an agreement to sign which contained terms different from those which had been arranged. He was not satisfied with them, and consulted with his solicitor, and wrote to the defendants asking for a proper agreement, and a meeting of the parties to negotiate the terms. He was shortly afterwards dismissed at a week's notice, and now claimed damages for wrongful dismissal. The syndicate was a failure, and was wound up on April 21st, 1899.

Mr. Tindal Atkinson said that during the period for which arrears of salary were claimed, the plaintiff was not conducting experiments at all. The money in the hands of the syndicate had given out, all the parties were endeavouring to obtain money, and the plaintiff agreed to take a commission on any capital he might introduce, but there was no agreement to pay a weekly salary during that period. With regard to the plaintiff's dismissal, that would turn on the construction of certain documents, but defendants had explicitly said that by the agreement of October 13th, they did not employ the plaintiff for a fixed term.

Council having addressed the jury on behalf of their respective clients,

His Lordship summed up, and the jury, after a quarter of an hour's deliberation, returned a verdict for the defendants.

Judgment was entered accordingly.

BILLS BEFORE PARLIAMENTARY COMMITTEES.

Mersey Railway Bill.

The Mersey Railway Bill came before Lord Morley's Committee of the House of Lords on Friday. The Bill authorises the company to use electric power and provide for the re-arrangement of the capital. There was no opposition to the Bill, and the preamble was found proved.

Wirral Railway Bill.

On Friday the Wirral Railway Bill, which authorises the company to use electricity as a motive power on that line, came before the House of Lords Committee presided over by Lord Morley. There was no opposition, and the Bill was declared approved.

South Staffordshire Tramways.

The South Staffordshire Tramways Bill was mentioned before Lord Jersey's House of Lords Committee on Friday.

Aston Manor Tramways.

The Bill of the Aston Manor Urban District Council came before a House of Lords' Committee on Thursday last week. The Bill authorises the Council to construct tramways to be worked by electricity. For the purpose of constructing the new tramways and electrical equipment and station, power would be taken to raise £27,000, and for the purpose of adapting and equipping other tramways in the district for mechanical traction such sums as might be required.

There was no opposition to the Bill, and it was ordered to be reported to the House.

South-Eastern and Metropolitan Tramways.

The Select Committee of the House of Commons, presided over by Colonel Cotton-Jodrell on Tuesday and Wednesday last week, considered the Bill of the South-Eastern Metropolitan Tramways Company.

Mr. Littler, Q.C., who appeared for the promoters, explained that the object of the Bill was to authorise the company to substitute electrical for horse traction on the tramway system between Greenwich and Catford. As it was considered that electric traction would be cheaper, the company hoped to run more cars to meet the convenience of the public. They asked for capital powers of £33,000 for the purpose of borrowing powers of £9,000; the company had nine years to run before they became subject to purchase by the London County Council.

The Committee passed the preamble of the Bill, there being little opposition.

Manchester and Liverpool Express Railway.

Sir John Kennaway's Select Committee of the House of Commons commenced the consideration of the above Bill on Tuesday last week.

Mr. Balfour Browne, Q.C., who appeared for the promoters, said the Bill authorised the incorporation of a company for the construction of a high-speed railway commencing in the centre of Manchester, and terminating in the centre of Liverpool. There would be no intermediate stations on the proposed line, and the competition with existing railways would, therefore, be solely for through traffic. The principal opposition to the scheme came from the three great railways running between Manchester and Liverpool—the London and North-Western, the Lancashire and Yorkshire, and the Cheshire lines. There had been a growing demand upon the part of the public for more rapid transit between Liverpool and Manchester, and the limit of speed upon ordinary railways on which locomotives were used had been reached. A speed of 80 miles per hour might be attained on a perfect road, but 60 miles an hour was as much as could be run with safety on an ordinary road. Electric traction had opened a new field for endeavour, and offered great advantages as compared with steam traction. On an ordinary railway the cars and the locomotive were only kept on the way by comparatively small flanges on the inner tyre, and the centre of gravity was far above the wheel base. In 1891 two well-known Continental engineers designed a railway upon the ordinary principle to run from Vienna to Buda-Pesth at the rate of 150 miles per hour; but to attain that speed the road had to be practically straight and absolutely rigid. To obtain rigidity the road was to be carried on a solid deal platform, but the expense of all this was so prohibitive that the project was not carried out. Mr. Behr had seen for many years that for great speed a change would have to be made in the construction of the permanent way and carriages, and he was the first to bring into vogue the monorail system, which would be applied to this undertaking. A single rail was laid on the top of trestles about 4 feet high, on which the

weight of the car was carried. Below the top rail were two guiding rails, which bore the latteral pressure when the car was rounding a curve. A line was constructed on this principle from Listowel to Ballybunnion, in Ireland, in 1886, steam locomotives being used, and it had proved that curves of no more than 54 feet radius could be rounded at considerable speed. The trestle was to be constructed of steel and bolted into sleepers. The motors were carried under the lower part of the car, and the centre of gravity would be 14 inches below the top rail, making derailment absolutely impossible. The centrifugal force was met or taken up by pressure on the guide rails. Trials were made in Brussels in 1887, which showed that the principle had passed out of the experimental stage. A road three miles long was laid in the Exhibition grounds, 75 per cent. of which consisted of curves, and with only 500 H.P. of electricity a speed of 83 miles an hour was attained without difficulty. The carriage on that railway weighed 70 tons and carried 100 passengers, but it was believed that a weight of 45 tons, including the motor, would be sufficient in the present case. Mr. Behr and his friends had spent over £200,000 to establish the feasibility of this system. It was proposed to run the trains at the rate of about 110 miles an hour, the journey between Manchester and Liverpool being accomplished in 20 minutes. The question was could it be done in safety?—The two risks were collision and derailment. It could be demonstrated that there was no risk of derailment. With the permission of the authorities of the House the engineers proposed to show the Committee a model of the proposed train at work. As to the danger of collision, he pointed out that there was to be a separate up line and down line without any junctions, stopping places, or level crossings, and that the only possible danger, therefore, was of one car overtaking another that had stuck on the road. He explained that, being a system of automatic "lock and block" signalling, this danger would be absolutely averted, such as was in operation on the overhead railway at Liverpool. The signals would be reproduced upon a dial that would be before the engineer travelling with each car. This would be valuable in case of fog or bad weather. The intention was to run a car each way every 10 minutes. The station for the manufacture of electricity would be at Warrington. It would then be carried by conduit pipes to the transformers. At the transformers the voltage would be reduced from, probably, 10,000 volts to 500 or 600. The electricity would then pass along the guide rails. It would be taken up by the guide rails and conveyed to the motor in the car, and that would produce the motive power. The length of the line, which was to be double, was 34 miles 4 furlongs and 5 chains, and the cost was £1,750,000, of which £401,600 was set down for land and buildings. This did not include the equipment. The capital proposed to be authorised was £2,000,000, and the promoters also sought powers to raise £660,000 by debentures. The working of the railway would be much cheaper than an ordinary line of railway. They calculated that, after paying 3 per cent. on their debentures and 4 per cent. on the preference, there would be sufficient to pay 5 per cent. on an ordinary capital of £1,000,000. Mr. Browne then proceeded to deal with the petitions presented against the Bill by the railway companies.

Mr. HAWKSHAW, vice president of the Institution of Civil Engineers, and jointly responsible with Mr. Behr for laying out the proposed line, was the first witness called. The line, he explained, began in Deansgate, Manchester, and terminated at the Bluecoat School in Liverpool. There were no intermediate stations, no crossings, and no shunting. These facts diminished the very many sources of danger on an ordinary railway. Having regard to the construction of the railway, he did not think there was any danger of derailment in rounding sharp curves, even at such a speed as 110 miles an hour. He regarded the estimates as ample, and the sum for contingencies, about £118,000, he thought was rather over than under estimated.

The witness having been cross-examined, the Committee adjourned.

The Select Committee considering this Bill sat again on Wednesday, May 9th, to hear further evidence, when Mr. F. BEHR, the projector of the scheme, said that for the last 14 years he had devoted his attention to the monorail system, and he and those connected with him in this matter had spent some £200,000 in experiments, the Brussels experiment alone having cost over £60,000. In that case, under exceptional difficulties as regarded gradients, curves, and lack of adequate power, the train made a speed of 83 miles an hour, but the course being only 3 miles long, the highest possible speed could not be attained. There was a remarkable absence of vibration. On a proper line, and with adequate power, there would be no difficulty in running 100 or 120 miles an hour. He believed this line would be an example and a pioneer, not only for this country, but the rest of the world. With regard to the present scheme the signals, he said, would be reproduced upon a dial in the electrical cabin of the train, which would be specially valuable in case of fog, and he had invented a special air brake, utilising the high speed of the carriage for the purpose of obtaining pressure. He claimed that on the monorail system derailment was absolutely impossible, thus avoiding one serious obstacle to great speed on ordinary lines. On the latter the centre of gravity was considerably above the metals; on his carriages the centre of gravity would be some 12 or 13 inches below the rail. There would be on this line no level crossings, no points, and no couplings, thus avoiding other sources of danger. With regard to the remunerative nature of the undertaking, he considered that they would carry 7,500 passengers per day, and that when people got used to the railway, many who wished would be unable to travel for want of accommodation. In cross-examination by counsel representing various interests, witness said his system was to start a carriage with 64 passengers, propel it to Liverpool at a high speed and follow it at a short interval with a second carriage over the same route propelled by the same motive power. He had travelled on his own line at Brussels at the rate of 90 miles an hour, and did not experience any different sensation from that of travelling on an ordinary express. He admitted that the presence of an electric current at, say, 1,000 volts pressure, and of a train rushing through the air at the speed mentioned, might constitute a real danger to the public without proper precautions, but in the same way every electric railway was a source of danger.

The Committee then adjourned.

On Thursday, May 10th, the Lord Mayor of Manchester gave evidence in support of the Bill, and said he believed the railway would be a great convenience to the public generally, and would be particularly useful to those engaged in the cotton trade.

Mr. COOPER, C.E., said he had been engaged for upwards of 30 years in the construction of railway, harbour, and other works, both of this country and abroad, and having minutely examined the plans for the construction of the railway, he had no doubt whatever that the scheme was perfectly feasible. It was admirably designed for the purpose of carrying passengers with perfect safety at a very high speed. As to the high rate of speed having a serious effect upon the passengers, he said that as a matter of fact, it was impossible for a person in a train to tell by the mere sensation at what speed it was travelling. On a well-laid road, the effect upon the passenger was no different whether the train was travelling 70 or 40 miles per hour. The centre of gravity in the proposed railway was below the level of the running rail, and this added to the safety of the line while the guide rails allowed a steadying process to be brought into play. The actual strain upon the structure on which the line would run would be exceedingly small, and well within the limits allowed by the regulations of the Board of Trade. The lower part of the carriage where the machinery was came very near to the ground, so that there was not much chance of the wind getting underneath and lifting the car off the line. There was very little about this scheme that could be called experimental, except the novelty of the monorail and the side rail. In his opinion, there would be no more risk of collision travelling at this high speed than there was on the existing railways. The railway could, so far as human ingenuity could devise, be worked with perfect safety.

Mr. GALBRAITH, civil engineer, having given evidence in support of the estimates,

Mr. SHELFORD, C.E., who said he had had considerable experience of railway construction, expressed the opinion that under the monorail system very high speeds could be run on ordinary curves, and thus obviate the cost due to large curves in the neighbourhood of large towns. He had seen the plans of the present proposal, and, in his opinion, the intended trestle work on which the rail would be carried could be constructed without any difficulty. The estimate for the permanent way was ample.

By Mr. LITTLER, Q.C.: He thought that when the side wheels which were to work at 1,700 revolutions a minute came into play there would be some vibration, but he could not say that it would be considerable. These side wheels would enable the car to go round sharper curves than an ordinary railway could without tipping off, and with greater comfort to the passengers, up to a certain point. What that point was remained to be determined by experiment.

The Committee then adjourned.

The consideration of this case was resumed on Friday, May 11th, when M. GERARD, the engineer-in-chief to the Belgian State Railways, expressed the opinion that the proposed line could be worked with safety.

A number of witnesses connected with industrial concerns along the proposed route having spoken in favour of the scheme,

Sir W. H. PREECE was called, and said he thought the proposed system of distributing the electrical power was eminently suitable to the purposes to be served. It had been amply tried in America and Switzerland, and also in Dublin, and was found reliable and safe. A constant load could be maintained if they had a regular service at frequent intervals, and this would be conducive to economy. He saw no electrical nor mechanical risks.

WITNESS was examined at considerable length with respect to the question of brakes, and he admitted that this was a difficult problem, because there had been no experience of brakes operating on trains going at 110 miles an hour. He thought it was practicable, however, to throw out *louvres* in front and so increase the air resistance to the train when desired, and he considered that it would be possible to stop a train going 110 miles an hour within 5,000 feet. In his opinion the project was sound from an engineering and commercial point of view.

The Committee adjourned before witness had finished his evidence.

At the sitting of the Committee on Monday, Sir W. H. PREECE again occupied the witness-chair, and said that the train would be fitted with the Westinghouse air brake and the *louvres* invented by Mr. Behr. He considered that with the appliances the train could be stopped within 1,500 yards.

Mr. BEHR was recalled to further explain an operation with the proposed *louvres*, and he stated that the engineer would press a button and the electric current would throw out a succession of plates in front of the car, exposing their surface to the pressure of the air. These plates could also be fitted on the top of the car, thus increasing the resistance.

In further cross-examination, Sir W. H. PREECE said he considered there was nothing simpler than to work the line by electric agency, and there was nothing better to secure absolute safety.

Mr. COTTRELL, engineer to the Liverpool Overhead Railway, and a member of the Liverpool and Manchester Committee, formed to

inquire into the feasibility of the scheme, said that while he did not agree that 110 miles an hour could be attained, there was no reason why they should not reach a regular speed of 90 miles an hour. 100 miles an hour was the maximum he would give. It was possible to bring a train, travelling at 100 miles an hour, to a standstill in 500 yards, but this would cause great inconvenience to the passengers. The more reasonable stoppage would be within 900 yards, which was the case to-day on the American electric railroad system. This could be accomplished by short-circuiting the motors, which would have the effect of an electrical brake. If there was no greater pressure than 500 volts, no danger could arise from contact with the line. The pressure of the Liverpool Overhead Railway was 500 volts, and there was no danger to their platelayers or anyone else connected with their line.

In cross-examination, WITNESS said he had little faith in the *louvres* for helping to stop the train.

Mr. PARSHALL, engineer to the Central London Railway, expressed the opinion that 110 miles an hour was a practicable speed which might be attained with safety on the railway, and similar evidence was given by Mr. E. HOPKINSON, of Salford.

Evidence was then called from gentlemen having large commercial interests in Liverpool and Manchester as to the boon such a railway would be to business men.

Nearly the whole of the sitting of the Select Committee on Tuesday was devoted to hearing evidence from surveyors as to land values, and from gentlemen interested in various industries as to the present unsatisfactory condition of the railway facilities.

Mr. W. MATHER, M.P., supported the promoters' proposals, and said he looked upon the railway as a pioneer scheme and an important object lesson to the whole country.

The case for the promoters having been closed, evidence against the Bill was submitted by the Urban District Council, who contended that while their roads would be seriously interfered with, they would enjoy no advantage from the scheme.

The whole of the sitting on Wednesday was devoted to hearing evidence respecting the interference with lands over which the railway would pass.

METROPOLITAN DISTRICT RAILWAY COMPANY.

COL. COTTON-JODRELL presided over a Select Committee of the House of Commons on Thursday last week, to take into consideration the Bill of the Metropolitan District Railway, which contained *inter alia* proposals for the erection of a generating station in Chelsea, for the purpose of supplying electrical power to work the company's lines and those of the Metropolitan Railway.

Mr. POPE, Q.C., who appeared for the Bill, explained that both the companies interested—the Metropolitan and the District had a general power of working by electricity, but the real difficulty in electric traction was in applying it to lines, where hitherto ordinary steam locomotives had been used. For over two years these two companies had been making experiments, with the assistance of Sir J. Wolfe Barry, to see how best to supersede steam by electric power on their trains, and they believed they had now arrived at a solution of the problem. By the Bill it was sought to acquire a site on the Thames, near Chelsea, on which to erect a generating station. From thence the electric power would be conveyed for the use on the railways by means of two lines of pipes conveying cables. The double lines were necessary, so as to provide for an alternative power in the event of one failing, through any cause.

Sir J. WOLFE BARRY in giving evidence in support of the Bill, said the substitution of electric traction on the underground would be of immense advantage to the public. He explained the nature of the experiments which had taken place on a short portion of the line between Earl's Court and High Street, Kensington, and said that these experiments had proved very satisfactory.

Sir W. H. PREECE gave evidence on Friday in favour of the Bill. Generally speaking he corroborated the evidence of Sir J. Wolfe Barry as to the successful results of the experiments which had been made on the underground railway, and said that in the coming week trains would be running by electricity for the conveyance of passengers between Earl's Court and High Street, Kensington. Underground travelling in London was, he thought, being revolutionised by electricity, and the question of ventilation would be solved.

Evidence having been tendered against the Bill on behalf of the London and North-Western and the Great Western Railway Companies, the Committee adjourned.

This Bill was concluded on Monday, when, after hearing evidence in opposition to certain parts of the proposal from the London County Council, the CHAIRMAN announced that the Committee had decided to pass the preamble of the Bill. The various clauses were then gone through, and the Bill was ordered to be reported to the House.

COUNTY OF DURHAM ELECTRIC POWER SUPPLY COMPANY.

(*Continued from page 778.*)

THE Committee sat again on Wednesday last week to further consider the Tyneside Electric Power Bill.

Mr. CAMPBELL SWINTON gave further evidence, and was further cross-examined by Mr. Page, who appeared for the Whickham and Gateshead Urban Councils, with regard to certain public roads, which Witness said there was no intention of stopping. They did not intend to break up streets without the consent of the local authority at Gateshead. That did not apply to the chief main, but to the mains which would be necessary to lay to supply inhabitants of Gateshead. He might take it that the local authorities he represented would be amply protected by the Bill from interference with the streets.

Replying to Mr. RICHARDS (who represented the Newcastle Electric Supply Company), Witness said he was aware that the company had a provisional order before the Board of Trade to supply Gosport, but he did not know that they had also a Bill to supply the district of Long Benton, which came in the Tynemouth district, which was included in the Bill. It was true that of the 19 districts included in the Bill 12 local authorities had petitioned against it. If the Bill was carried they would open negotiations with the different authorities and proceed, if possible, to supply at once. The seven authorities whom they had agreed with comprised the greater portion of the area. The whole success of a scheme of that kind depended on embracing a very large area, and they could not get all the local authorities to agree straight away, and so they had to make arrangements before they could get all to agree. They were not so anxious to do the work of general distribution, but would rather have other companies step in and do this, while his company would supply in bulk. He thought it would take them a year to get fairly started if the Bill passed. Wallsend would be their chief generating station, for he believed that had been scheduled for compulsory purchase by the Newcastle Electric Supply Company. They would probably supply what was known as a two-phase or three-phase system, and the pressure would be 10,000 volts. It was an alternating system. They had not quite settled whether they would give a direct current, but probably they would give both continuous and alternating. He would not pledge himself to supply both everywhere, where it might not be wanted. The question of the price they would charge would depend on the length of time for which the current was used.

Asked by the CHAIRMAN to state what the company really intended to charge, WITNESS said they had offered the following rates to every local authority:—Where the local authority itself distributed and the company supplied only in bulk, they would charge for the first 100 hours at 4d. per unit; for the second 100 hours at 1½d. per unit; and for the third 100 hours and subsequent hours at 1d. per unit. Where the company distributed itself they would charge for the first 100 hours at 5d., for the second 100 at 2d., and for the subsequent hours 1½d. They also offered to supply for manufacturing purposes at 3d. for the first 100 hours, and for subsequent hours ·9 of a penny.

WITNESS was then cross-examined by Mr. MOON (representing the County of Durham Power Supply Company), and said that the County of Durham Electric Distribution Company had power to supply certain districts which his company sought power to supply. He did not think it would be possible for the Distribution Company to supply large works unless they took power in bulk, and his company would be happy to supply them in bulk. He was a manufacturer in the district, and the gentlemen interested in the promotion of the Bill were manufacturers who were seeking to supply themselves at a cheap rate with motive power, and certainly they would not bind themselves not to supply manufacturers more cheaply than to the authorised undertakers.

By Mr. SQUARREY (for the Tynemouth Corporation): He was aware that the Tynemouth Corporation had powers for electric lighting, but they had not exercised them for nine years. They were now putting up a generating station.

Witness was further examined by Council for the Walker District Council, the Clavering Trustees, and the Jarrow District Council. He said that the Tyneside Bill was hardly on all fours with the Lancashire Bill, which had been modified, but they did not ask for anything more. The Lancashire Company had agreed to a clause making it perfectly clear that they should not take powers to distribute even in bulk without the consent of the local authority. He did not know that he asked for anything more.

On Thursday last week the whole of the sitting was devoted to hearing the evidence of gentlemen having commercial interests in the locality in favour of the Bill.

Mr. WORTH, a large manufacturer, stated that he had arranged with the promoters for a continuous supply of electricity for his works. He estimated that he would be in a position to take 5,000 H.P.

The Hon. C. A. PARSONS, one of the promoters of the Bill, gave evidence at considerable length as to the importance of the scheme, and stated, in the course of cross-examination, that the whole of the mains would be underground, and that it was not intended to carry the cables overhead.

WITNESS was questioned by the CHAIRMAN as to the proposed charges, and as to whether there was not a possibility of the smaller consumer being prejudiced, and he agreed that it might be advisable to protect the small consumer against undue preference.

Mr. J. M. DAVIDSON, the managing director of the United Alkali Company, at Newcastle, said that if his company could obtain such a supply of electric current as was contemplated being supplied by the promoters, it would be of the very greatest advantage to them. He expressed the opinion that it would be unfortunate if the Tyneside Company was not allowed to supply south of the Tyne.

Mr. N. COOKSON, who is connected with various large industrial concerns in the locality affected by the proposals, said he considered that if Parliament allowed the Bill to pass, the scheme financially would be a great success.

On Friday the morning was occupied by hearing evidence from a number of local witnesses in favour of the Bill of the Tyneside Company. Among those called were Mr. C. McLaren, chairman of Palmer's Shipbuilding Company; Mr. Eustace Smith (Smith's Shipbuilding and Docks Company); Mr. T. Tweeddale (chairman of the Newcastle Wholesale Co-operative Society); Mr. Simpson (chairman

of the Ryton Urban District Council); Mr. Browell (chairman South Shields Rural District Council); and Mr. Robson, late chairman of the Benwell and Fenham Urban District Council.

Lord KELVIN, replying to Mr. BAGGALLAY, said he was satisfied that electrical power of very high voltage could be safely transmitted to very long distances. He had examined the scheme of the Tyneside Company, and was of opinion that it was calculated to give the district a good supply of electrical energy in the cheapest and most effective form. He thought it would be a bad thing if the Committee were to limit the Tyneside Company to the north side of the Tyne. There would be no practical difficulty in taking the current across the Tyne—it could be laid under the bed of the river with perfect safety. With regard to the question of competition, competition within an area where two bodies—either local authorities or companies—competed for customers, would be undesirable as a general rule, but competition between two supply producing bodies for supplying bulk to local authorities and others for general distribution stood on a different footing. The first sort of competition would involve waste, but the other would not.

By the CHAIRMAN: He considered that Great Britain was very much behind America and other countries in the use of electrical energy, and he was of opinion that, as far as possible, Parliament should facilitate the development and the use of electrical energy in bulk. With due regard to the rights of individuals, he thought that Parliament should give the greatest freedom possible in this matter. As to the smallest quantity of electrical energy which could be economically produced, he would place the figure at 1,000 H.P., but he should say that for the purposes of the Tyneside Company, a convenient commencement would be with from 3,000 to 4,000 H.P. He thought there would be plenty of demand for the power when it was available.

Mr. PLUMMER (secretary to the Newcastle and Gateshead Chamber of Commerce) said that he believed that the Bill would be of great advantage to the inhabitants and manufacturers of the district.

Mr. J. SWINBURNE, consulting engineer, and vice-president of the Institution of Electrical Engineers, said he had had over 20 years experience in connection with electrical matters. He knew the district of Gateshead and Newcastle fairly well, and having examined the scheme of the promoters of the Tyneside Company's Bill, he should say it was one of the very best schemes he had ever seen. The district to be supplied was a very compact, and contained a large number of manufactories. It would be unfair if the company were not allowed to go south of the Tyne. A company could begin to supply power economically at between 4,000 and 5,000 H.P., and after that, as the production increased, the economy would increase. He agreed with Lord Kelvin's views as to competition.

The Committee adjourned until Monday.

On Monday the examination of Mr. SWINBURNE was proceeded with. He said that manufacturers would get greater benefit by being supplied by one large concern rather than if the district were split up and served by a number of small companies. He had recently made it his business to visit large power stations, including the one at Niagara, another on the falls of the Rhine, and another in the north of Italy, and his experience was that the district to be supplied should be a large one, in order that the fullest advantage might be obtained.

This closed the case for both Bills.

Mr. J. F. SMILLIE, the borough surveyor of Tynemouth, called in opposition to the Bill, said that in 1891 the Corporation of Tynemouth obtained a provisional order for supplying electricity to the borough both for public and private purposes. There was no demand, however, for the light at the time, and the Corporation did not proceed with the works to carry out the order. That was largely owing to the fact that the local gas company had certain rights pertaining to the lighting of the streets, and the Corporation were precluded from entering into the question of public lighting. In 1897, however, those powers were repealed, and in the following year the Corporation called in a firm of consulting electrical engineers to advise them respecting the establishment of an electric installation for the borough. Last year, too, there was a change in the local tramways company, and the new company proposed to run the line by electricity. The work of providing the installation had been commenced some time ago, and the Corporation would be in a position to supply power in about a couple of months. Every provision had been made to enlarge the supply of power if the demand increased, and if their area of supply was not encroached upon by the Tyneside Company, they looked forward to their installation being thoroughly successful. The Corporation looked upon the scheme of the Tyneside promoters as one which would involve much unfair competition to which they strongly objected.

In reply to Mr. H. LLOYD, WITNESS admitted that the Corporation had not had under consideration the desirability of supplying anything like the amount of power as was proposed by the promoters of the Bill.

Mr. SQUARREY, Q.C., having addressed the Committee on behalf of the Tynemouth Corporation in opposition of the Tyneside Bill, was followed by Mr. Page, Q.C., in the same direction on behalf of the Gateshead Corporation.

The CHAIRMAN said he wished to inform petitioners against the Bill, whether local authorities or others, that the position of manufacturers who were within the district of a local authority and who wanted a supply in bulk, was occupying the attention of the Committee. If the local authority was unable or unwilling to give such a supply or to give it only at a prohibitive price, the inference was that manufacturers must go without.

Mr. N. TEMPERLEY, the vice-chairman of the Parliamentary Committee of the Gateshead Town Council, explained the arrangements which the company had come to with the promoters of the County of Durham Bill. He said that they had come to terms and arranged to support that Bill on the understanding that they would have a right to purchase the installation at the end of 13 years by giving two years' notice.

Replying to the CHAIRMAN, WITNESS said there were a large number of manufacturers in Gateshead who would be likely to take a supply of power in bulk if the opportunity was offered.

Mr. SHORTT addressed the Committee against the Bill on behalf of the local authorities of Wallsend and Gosforth, and argued that there was no valid reason why at any rate the latter town should be included in the Bill. As to Wallsend, that was no doubt a thickly populated district, and there were a considerable number of manufacturers there, but their requirements for electrical power would be supplied by the Walker & Wallsend Gas Company, which was now erecting a generating station for that purpose.

Mr. DAVID HETHERINGTON, chairman of the Gosforth District Council, and Mr. GEORGE HOLLING, surveyor of the Wallsend District Council, having given evidence bearing out the counsel's statement, the Committee adjourned.

At the opening of the proceedings on Tuesday, the CHAIRMAN said the Committee proposed to hear the promoters of, and the opposition to, each Bill before they gave their decision. They would give no decision on the Tyneside Bills until they had heard the cases for and against the other Bills in their list. As the cases were different they might find principles in those Bills which were not to be found in the others.

Mr. PEMBER, Q.C., on behalf of the Newcastle Corporation, said that in Newcastle there were two companies for the supply of electricity, and in addition the Corporation had the power to supply their own tramways with electrical energy and to light their own streets. The town, therefore, was well supplied in the matter of electrical power, and they did not see the necessity for a new company coming in.

Mr. SMITH followed, on behalf of the Walker Urban District Council, in opposition to the Bill; the passing of which in its present form would, he said, place the Tyneside company in a position to compete most unfairly with the Council in the matter of the supply of electrical energy.

Mr. J. M. REYNOLDSON, member of a large shipbuilding firm on the Tyne and a past Mayor of South Shields, said that in 1891 the Corporation of that borough obtained an electric lighting provisional order, and in 1893 an Electric Lighting Committee was appointed, of which he was chairman—to put the order in force. After visiting several towns and acting on the advice of an electrical engineer, the Corporation adopted the alternating high pressure current system, with transforming sub-stations. They commenced to supply light in September, 1896, with four or five consumers, and from the very commencement the demand for current steadily increased, and before the works had been open a few months it was found necessary to increase the plant. Further additions were subsequently made, and at the present time they had seven transformer sub-stations in different parts of the borough. The initial capital expenditure was £30,000; now it stood at about £100,000, and a further expenditure of £40,000 had been sanctioned for completing the distributing system. The Corporation had always been anxious to supply for power purposes, but up to the present there had been practically no demand in that respect. If the Tyneside Company were allowed to come in and take the "plums" in the district, the undertaking of the Corporation, which was now profitable to the ratepayers, would be seriously jeopardised and prejudiced.

Cross-examined, WITNESS admitted that the alternating system which the Corporation had installed was the least adapted for the supply of power, but they would be willing, upon demand, to spend further money to lay down other plant for the purposes of supplying power. He believed the taking of power for manufacturing purposes would be an exceedingly slow process.

(To be continued.)

ELECTRICAL GENERATING STATIONS AND THE FACTORY ACT.

THE Electric Light Committee of the Coventry Corporation have made representations to the Home Office, through Mr. C. J. Murray, M.P., with respect to the provisions of the Factories and Workshops' Bill of this session with regard to electrical generating stations.

The following memorandum drawn up by the town clerk states the position from the point of view of the Committee, and this was laid by Mr. Murray before the Home Office authorities:—

"The question whether electrical generating stations are within the Factory Acts is open to some doubt, and contrary opinions have been given by high authorities. The present Bill proposes to include them specifically under Clause 42, no doubt with the intention of applying to them the powers of Clauses 1 to 4 with respect to dangerous trades.

"In 1897 a Departmental Committee of the Home Office reported recommending certain rules for securing the safety of workmen, &c., engaged in electrical generating stations. These rules were formulated without giving those interested in the management of such stations an opportunity of being heard, and were considered in some quarters to be unworkable. They do not appear to have been generally insisted upon, as objection was raised in many places, and probably the Home Office did not feel sufficiently secure in their position in the matter. The provisions of the present Bill with

respect to electrical generating stations are, no doubt, to some extent the result of this uncertainty.

"The Bill proposes (Clause 2, &c.) to give the interests affected an opportunity of being heard before any regulations are made. This is, no doubt, a great improvement upon the procedure which was adopted in 1897. But it is suggested in some quarters that the procedure adopted by the Board of Trade in 1895, when revising their regulations for securing public safety in connection with electrical installations, might be adopted with advantage in the present instance. In that case, after the regulations had been adopted by the Board, they were submitted to the various bodies interested for their observations, and a conference was subsequently held under the presidency of Sir Courtenay Boyle, to which everybody supplying electricity in the kingdom was invited to send representatives. There was a very large attendance, and, as a result of three days' discussion, a code of regulations was settled which met with general acceptance, and have worked satisfactorily.

"It is generally admitted that the electrical industry is still in somewhat of an experimental stage in this country, and no doubt the different companies and corporations are accumulating experience, not only on technical questions, but on practical questions of working. This experience would, on the one hand, be of value to the Home Office in forming regulations, and, on the other hand, is entitled to a hearing before such regulations are settled. The machinery of a conference seems more suitable for eliciting the results of this experience than that proposed by the Bill, which involves in the last resort something in the nature of litigation."

As a result of this action, Mr. Murray received a letter from the Home Office, which stated "that it is the practice of the Home Office, in preparing special rules, to allow the persons interested opportunities of stating their views, and that if regulations are proposed for the electric lighting industry, the draft rules will be communicated to the companies and corporations concerned, and full consideration will be given to any representations they may make, and that, if necessary, a conference will be arranged between the officers of the Home Office and representatives of the trade."

The Committee considered this reply placed the matter upon a satisfactory footing.

CORRESPONDENCE.

Parsons' Steam Turbine.

In your issue of April 27th you give an interesting note by Mr. Ed. C. de Segundo on the recent test of a Parsons steam turbine made by the Westinghouse Machine Company, of America, under our patents. In October, 1899, tests were made on behalf of the Cambridge Electric Supply Company by their engineer, Mr. J. H. Barker, of a nominal 500 KW., but intended for 600-KW. turbo-alternator, which gave the following consumptions :—

Boiler pressure	127	139	145	140
Vacuum	24·75	24·5	26·5	27·5
Barometer	29·6	...	...	...
Water per hour (lbs.) ...	13,400	12,675	7,029	4,180
Output in KW....	598	526·4	256 1	124
Water per KW.-hour	22·4	24·1	27 5	33 7
Exciting current (KW.) ...	3 5	3·3	3 1	3·0

The temperature due to a boiler pressure of 127 lbs. is 354° F., or 815° absolute, and to a vacuum of 24·75″ with the barometer at 29·6″ is 133° F., or 594° absolute.

22·4 lbs. per KW. = 16·7 lbs. per E.H.P.

By Rankine's cycle the theoretical consumption of steam would be 9·6 lbs. per H.P. which gives an efficiency of 57·5 per cent.

In the Westinghouse tests the steam pressure was 125 lbs. and the vacuum was 28″, corresponding to a theoretical consumption of 8·2 lbs. per H.P. Their consumption was 16·4 lbs., giving an efficiency of 50·0 per cent., which almost agrees with Mr. Segundo's figures of 47·73 per cent. obtained by a different method. We may say that we generally obtain results giving from 55 to 62 per cent. of the theoretical consumption with our turbo-generators, and that with 28″ vacuum the consumption of the Cambridge plant would certainly have come considerably below the figures obtained in America.

C. A. Parsons & Co.

Newcastle-on-Tyne, *May 8th*, 1900.

The Lundell Generator.

Under the title of "The Johnson-Lundell Electric Traction Company, Limited," on page 652 of the ELECTRICAL REVIEW of April 20th, 1900, is given a description of a Lundell generator, the supposed novel feature of which consists in extending the field pole in the direction of revolution, so as to throw the gap between two consecutive field poles forward, instead of having it, as usual, midway between the field poles, and the field poles are also given slots which virtually divide the poles into two.

I would call attention to the fact that the extension of the field poles forward in the direction of revolution in generators is very old, as is evident by an inspection of the United States patent to E. J. Houston and E. Thomson, entitled "Dynamo-Electric Machines," No. 219,157, and dated September 2nd, 1879. There is also a corresponding British plan, the number and date of which I do not have at present for reference.

The expedient of dividing the field poles by slots, so as to make one or more sections of the field pole, is also quite old, as those who are familiar with the development of the art must know. Moreover, it is an expedient of very doubtful utility. I do not think it has any other effect than to increase the general reluctance of the field pole.

Elihu Thomson.

Lynn, Mass., *May 1st*, 1900.

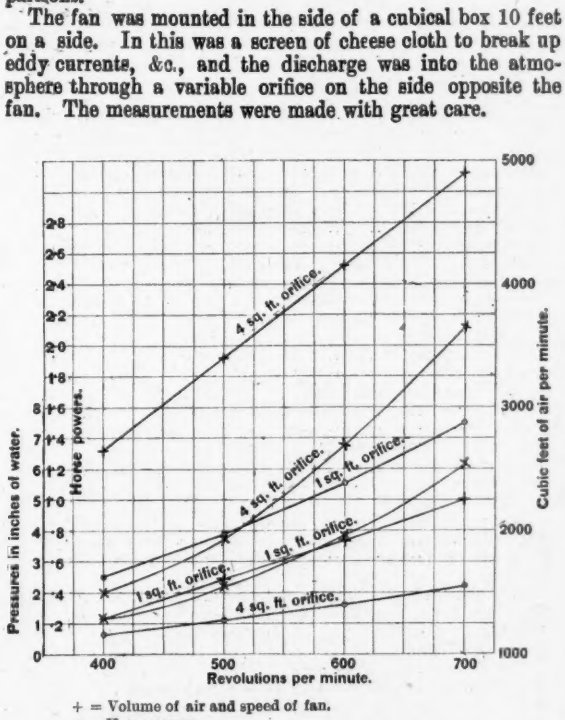
[Prof. Thomson's letter is very interesting, affording as it does yet another instance of the extraordinarily wide range of invention covered by his versatile genius. Yet, with due deference to his authority, we must point out that the extended pole without the slot, and the slot without the extended pole, are equally ineffective in preventing distortion of the field; it is in the successful combination of these two features that the merit of the invention consists.

We have had an opportunity of conversing with a well-known engineer who has thoroughly tested the machine in question, and he assured us that the results were most satisfactory.—EDS. ELEC. REV.]

Test of a Ventilating Fan.

In regard to the ventilating fan test recorded in your issue of March 23rd, the following data of a test on a 30-inch Blackman fan made several years since may be of interest, though I am well aware of the dubious nature of any comparisons.

The fan was mounted in the side of a cubical box 10 feet on a side. In this was a screen of cheese cloth to break up eddy currents, &c., and the discharge was into the atmosphere through a variable orifice on the side opposite the fan. The measurements were made with great care.



+ = Volume of air and speed of fan.
× = Horse-power " " "
⊙ = Inches of water pressure in house and speed of fan.
Curves are given for 1 sq. ft. opening of discharge.
" " 4 sq. ft. " "

Power was taken from a 7·5 H.P. 220-volt Thomson-Houston motor used as a dynamometer and investigated with great care.

The test was part of a long series on different makes of fans, and was checked as to results several times by independent observations.

The curves are quite interesting, I think.

Wm. Lincoln Smith.

Lab. of Elec. Eng.,
Mass. Inst. Tech., Boston, Mass.
May 4th, 1900.

Information Wanted.

Can you, or any of your readers, inform me where double cotton-covered tinned annealed iron wire, also d.c.c. zinc and aluminium wires of about No. 18 and 20 gauge can be obtained? In view of the continued high price of copper other materials should be used, and I believe it is not impossible to do away with copper altogether in certain types of motors, and still produce efficient and economical machines of the cheaper sort.

N. C. W.

Paisley, N.B., *May 5th*, 1900.

*** Wiremen's Woes.—As we have received several letters of a personal and more or less abusive nature, we think that no useful purpose will be served by prolonging the correspondence on this subject. The writers elect to shield themselves behind a *nom de plume*. The matter may therefore be considered closed.—Eds. Elec. Rev.

*** The Protection of Insulated Wires.—There has come to hand too late for insertion in this week's issue a communication from Mr. Fred. Bathurst, commenting upon Mr. S. F. Walker's article in the Electrical Review on the above subject. This will appear in our next issue.—Eds. Elec. Rev.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending May 16th, 1899.		Week Ending May 15th, 1900.	
Adelaide	Value £282	Adelaide	Value £76
Alexandria	183	Amsterdam	160
Amsterdam	12	Auckland	35
Beyrout	50	Azores. Teleg. mat. ..	1,154
Bombay	182	Barcelona	26
Bordeaux	72	„ Teleg. wire ..	102
Boulogne	164	Boca	230
Buenos Ayres	210	„ Teleg. mat.	79
„ Teleg. mat. ..	431	Bombay	505
Calcutta	445	Borkum. Teleg. cable ..	21,200
Cape Town	1,036	Buenos Ayres	103
Christchurch	146	„ Teleg. mat. ..	112
Colombo	156	„ Teleph. mat. ..	88
„ Teleg. cable ..	35	Calcutta	843
Delagoa Bay	34	Cape Town	39
Durban	546	Colombo	27
East London	605	Demerara	41
Gibraltar	41	Durban	322
Grenada	17	„ Teleg. mat. ..	101
Hamburg	200	East London	82
Jersey and Guernsey ..	421	Fremantle	56
Malta	14	Gibraltar	110
Melbourne	281	Hamburg. Teleg. mat. ..	400
Odessa	200	Hong Kong	16
Oporto	6	Karachi	240
Otago	173	Kobe. Teleph. cable ..	745
Penang	21	Malta	186
Pireus	590	Mauritius. Teleg. mat.	63
Port Chalmers	232	Melbourne	136
Port Elizabeth	220	Ostend	28
Rio Janeiro. Teleg. mat. ..	53	Otago	70
Santos. Teleg. mat. ..	100	Rangoon	252
Shanghai. Teleg. mat. ..	4,710	Rosario	52
Singapore	80	Stockholm. Teleg. mat.	88
St. Petersburg	102	Sydney	1,453
Sydney	497	Wellington	400
Tientsin. Teleg. mat. ..	262	Yokohama	3,730
Vigo. Teleg. mat. ..	253	„ Teleph. appts. ..	90
Wellington	144	Zanzibar	40
Yokohama	98		
Total ..	£13,099	Total ..	£33,580

Foreign Goods Transhipped.

Perth. Elecl. machinery. Value £369

Bankruptcy Proceedings.—A first and final dividend of 5s. 7d. in the £ was payable on May 16th in the case of W. H. F. Bowman, photographer and electrical engineer of Gainsborough.

Liquidations and Dissolutions.—The National Gas Engine Company, Limited, is winding up voluntarily, with Mr. John Smith, of Ashton-under-Lyne, as liquidator.

The Doe Portable Electric Light and Power Syndicate is winding up voluntarily for the purposes of reorganisation. A new company, with £40,000 capital in £1 shares is to be formed. Mr. J. E. Ward, of 122, Cannon Street, E.C., the liquidator, has power to carry through certain agreements.

The Phœbus Solder and Electric Soldering Fluid Company is to meet at 52, Aytoun Road, Stockwell, on Monday, June 18th, to receive an account of the winding up from the liquidator, Mr. S. Shortman.

A similar meeting of the Nalder & Harrison Construction Syndicate will be held at 19, Queen Victoria Street, E.C., on June 16th. Liquidators, J. A. McMullen and N. F. Nalder.

Book Received.—"Elektrometallurgie und Galvanotechnik," by Dr. Franz Peters, in four volumes. Wien: A. Hartleben's Verlag. 3k 30h each.

Catalogues and Lists.—Messrs. John Turner & Sons, of Denton, near Manchester, have sent us a tabulated list with lithograph, giving full particulars of their enclosed dust-proof motors. The list contains information as to output, speeds, and prices of the various sizes. These machines may be used as dynamos or motors, and can be supplied either totally or only partly enclosed. They are stated to be made on the very latest principles, embodying all the most recent improvements. The machines are designed to run at exceptionally low speeds, which is a desirable and important feature in an enclosed dynamo or motor.

Mr. G. Braulik, of Upper Thames Street, sends us a copy of his new price list of the continuous current "F" arc lamps manufactured by Messrs. Koerting & Mathiesen. Prices of reflectors, carbons, covers, resistances, &c., are included. We understand that the sales of this lamp are continually on the increase, and among his customers Mr. Braulik has some of the largest electrical engineers and corporations in the country.

The British Thomson-Houston Company's pamphlet, No. 63, gives particulars of direct connected continuous current lighting generators.

Messrs. Geipel & Lange send us a circular giving sizes and prices of vulcanised braided electric light conductors, and of the Brown-Boveri single-phase alternate current motors, for which they are London agents.

Messrs. Jones & Horsfield send a list of the Jones sectional and removable boiler and steam pipe insulator, giving a list of some Government departments and large steam users who have adopted the covering.

Messrs. Webster & Bennett, of Coventry, send us one of their catalogues of machine tools. The book contains many excellent illustrations of boring, drilling, chucking, and milling machines, and various lathes, of which general particulars and prices are given.

Mr. H. Hodgson Wright, of Globe Works, Halifax, sends us a number of his illustrated price sheets. One of the lists describes Fynn's patent winding enclosed type motors for continuous current, and others show high voltage spring contact switches, quick-break cross-handle switches, and accumulator switches, which are manufactured at the Globe Works. For the motors Mr. Wright has a manufacturing license from Messrs. Rosling & Appleby, of Bradford. Other types of switches besides those mentioned are manufactured.

From the Hiram S. Maxim Electrical Corporation, Limited, we have received an advance proof of their catalogue of the "Maxim" electric lamp. The average efficiency of the lamp is placed at 3 watts per candle-power throughout the whole life. There are notes for consumers and prices, and neat illustrations of standard lamps, also cylindrical, flame, and olive-shaped lamps.

Correspondence Instruction.—The Electrical Engineer Institute of Correspondence Instruction has removed from 120-122, Liberty Street, New York, to its new quarters at 240-242, West Twenty-third Street, New York, U.S.A. The growth of the Institute has been so rapid that the old quarters some time ago became inadequate to meet the demands for space, an indication that speaks well for the work done by the Institute and its president, Mr. Joseph Wetzler. The Institute has a vast number of students located all over Great Britain and the Colonies, as well as in the Western Hemisphere, and carries on its work in nearly every civilised country on the globe. Students study under the personal supervision of competent electrical engineers, and the text-books used are prepared by the best practical experts. The latest catalogue gives full information regarding the courses taught.

Cheshire.—The *Financial Times* says that Mr. Scotter's light railway syndicate, whose undertaking will shortly be the subject of a Commissioners' inquiry, intends making a complete electrical tramways system between Warrington and Northwich, and also in the latter town.

The United Alkali Company has bought Wimholdsley estate for £130,000, and intends erecting chemical works there, while at Middlewich the company is building a factory for new electrolytic process.

Conduit Casing.—We have had submitted to us samples of a new casing now put on the market by Messrs. Beecroft and Wightman, Limited, Bradford, as Hudson's patent wood-lined steel conduit. The metal part of the casing, galvanised steel, contains a single channel wood casing (which can be chemically treated, if required, to resist the action of flame or heat), and gets over the objection some engineers have to conduit wiring, as the cover can be removed for inspection at any point; an ingenious form of junction box has been devised. The makers claim that for ease of fixing and wiring, cheapness, and accessibility, it is unequalled, while it is impervious to damp or corrosion. Full particulars are advertised, and illustrated lists will be sent on application.

Electrical Coal Trimming Plant for India.—*Indian Engineering* says that the Port Commissioners of Calcutta resolved that Messrs. Brown, Hoisting and Company's electrical coal trimming

plant should be procured at a cost of Rs. 45,000 for trimming coal on vessels at the Kidderpore Docks. The plant will be capable of trimming 320,000 tons of coal a year, and thus effect a saving of Rs. 20,000, or 45 per cent. on its capital cost.

Electrical Imports.—The value of the imports of foreign electrical plant and apparatus imported into this country during April last amounted to £58,714, as compared with £73,085 in the preceding month. The total for the first four months of the year is returned at £255,732.

Electrical Power at the Packing Houses of Armour Co., Chicago.—By the introduction of electrical power throughout the immense packing establishments of Messrs. Armour & Co., of Chicago—the largest beef and pork packing business in the world—another instance is added to the many that already exist of the advantage and economy of electric power as compared with the existing methods of power distribution. Hitherto, the numerous mechanical functions were performed by 16 engines and 17 refrigerating machines. To these steam was supplied from 93 boilers situated in 12 boiler houses, scattered over an area of some 60 acres. The central generating and distributing plant just installed is of 5,000 to 6,000 H.P., and the cost including buildings and machinery installed, is considerably in excess of $1,000,000. It is stated that the saving will be about $300,000 per annum, and that it will be possible to dispense with the services of from 300 to 400 men. Mechanical stokers and other labour-saving devices are used so that not a spade or a shovel is used by hand in the operation of conveying the coal from the railway trucks for consumption in the boiler furnaces and in removing the ashes. The average size of the motors installed is 25 H.P.

Embezzlement.—At the Aston Police Court, on 8th inst., Joseph Aylieff, for embezzling moneys of the British Electric Works Company, was sentenced to six months' hard labour. He admitted having gambled the money away.

France.—A company has just been formed at Chalons-sur Marne with a capital of £17,200, to be known as the Société pour la Fabrication du Carbure de Calcium.

Germany.—Messrs. Siemens & Halske, of Berlin, are further increasing their capital from £2,250,000 to £2,725,000.

Grimsby and Cleethorpe.—The *Financial Times* says that some of the engines for the Grimsby and Cleethorpe Electric Tramway service "are being built by the Robb Engineering Company, a Canadian concern whose name is not infrequently heard in connection with such work."

Meldrum's.—From our "New Companies Registered" in another column it will be observed that the firm of Meldrum Bros., of Manchester—whose specialities, the "Meldrum" furnace, the "Koker" stoker, and the "Simplex" destructor, are so well known—are converting their business into a limited liability company. Ordinary stock will be taken by the vendors, and £50,000 5 per cent. preference shares are to be issued to the public. The object of the issue is, we understand, to provide additional and extensive works to meet the great demand for the firm's productions.

New Electric Car Works at Wellington.—The Old Castle Ironworks, which have been in recent years partially dismantled, have been acquired by a north country syndicate, and they have been reconstructed for the purpose of producing electric cars on an extensive scale. The works and plant now being laid down will be equal to the production of 1,000 electric cars per annum, and employment will be found for 800 workpeople. Three large dynamos will work electric motors in all the different workshops, and also supply the light. The drilling, planing, turning, and polishing machines are all worked by electric power. The manager of the new works is Mr. Carl Busch, whose father was the pioneer of electric car construction on the Continent.

Notes for Boiler Owners and Users of Steam Power.—The Vulcan Boiler Insurance Company have published a pamphlet dealing with the present position of boiler legislation. It is recalled that whereas pressures are now commonly 80 to 100 lbs. and pressures of 160 to 200 lbs. by no means exceptional; the boiler of the Comet was worked at 3 to 4 lbs. in 1812, while in 1829 the Rocket locomotive carried 50 lbs. Boiler-making did not keep pace with the demand for high pressures and consequently there were frequent explosions. The commencement of boiler inspection associations dates from 1854. The Vulcan Company, under another name, commenced in 1859, and others followed and speedily exerted great influence on boiler design. They were soon in possession of a great mass of evidence that pointed clearly to certain distinct causes of explosions. A single explosion carries little weight of evidence, but when a dozen explosions all occur in which one factor stands out prominently, it is good evidence that that factor needs special attention. The earlier attentions of Parliament to the question have not been drastic, but the Act of 1882 had considerable effect in bringing boiler owners to a sense of their responsibility. Of late, some Bills have been introduced, notably one by Mr. Fenwick of a very bad type, calling for needless and harassing provisions as to inspection by a class of men that has been proved to be less suited than certain other classes for the special duty involved. Fortunately the sense of the House caused the Bill to be withdrawn. It appears that of 40,000 boilers in charge of the Vulcan Company no lives were lost by the three very minor explosions published by the Board of Trade as having occurred to these boilers in their last annual summary of 50,000 boilers inspected by other companies; one life was lost by eight explosions. Lloyd's are debited with 11 explosions and one life. The great Board of Trade debits itself with two explosions and two lives, and other marine agencies with two explosions and no lives. The figures really show a practical immunity of inspected boilers, whereas about 80,000 uninspected boilers show 42 explosions and 32 lives, as well as 60 persons injured, whereas only seven were injured under inspection. Do not these figures amply prove that further legislation is almost unnecessary, and that the efforts of the companies and public opinion is sufficient? The one little bit of necessary legislation that we would sanction would be that every boiler should be in some way registered, and a certificate of competent inspection produced, failing which the Board of Trade should have the power to nominate an inspection company, or should, if it wishes, take the boiler under its own wing.

Substitute for Red Lead.—The difficulty of keeping tight joints in the high pressure steam piping now generally in use is a constant worry to the central station engineer, who will welcome any means by which it may be overcome. A substance called "manganesite" is now being introduced, which, it is claimed, is far superior to red lead composition for all joints exposed to steam and water. The material is in the form of an oily black paste, resembling "blacking," which remains soft indefinitely when stored in a closed box or under water; it is stated that 1 lb. of manganesite will go as far as 3 lbs. of red lead, and the joint, once made, improves with age. Manganesite, which is to be had from the Manganesite Company, 31, Snow Hill, E.C., is strongly supported by testimonials, &c., from engineers, but the most reliable test is that of a practical trial, which we strongly recommend.

Switzerland.—The report for 1899 of the Motor Gesellschaft für Angewandte Electricität, of Baden, Switzerland, shows a profit of £13,820; a dividend of 7 per cent. is being declared.

Trade Announcements.—Marconi's Wireless Telegraph Company, Limited, has changed its registered office to 18, Finch Lane, Threadneedle Street, E.C.

Mr. A. J. Hollington, who is well known amongst electric wiring contractors, has joined the directorate of Messrs. J. D. F. Andrews and Co., Limited, and has undertaken the management of their City branch. This branch was opened under Mr. Hollington's superintendence a few months ago for the purpose of more readily effecting the sale of every class of electrical appliance, in addition to the numerous patent specialities of Mr. J. D. F. Andrews. We understand that the company's factory at Fulham has been more than trebled in extent during the past few months, and preparation has been made for warehousing every class of electrical appliance in regular demand.

Wm. McGeoch & Co., Limited.—The firm of William McGeoch & Co., brassfounders, makers of electric fittings and manufacturing electrical engineers, of Glasgow, London, and Birmingham, has been converted into a private limited company with a capital of £100,000. The directors are Messrs. William McGeoch, Glasgow; Alexander McGeoch and William McGeoch, jun., Birmingham; L. A. McGeoch, William Roxburgh, and Robert Archibald (all of Glasgow). The registered offices are at Morrison's Court, 108, Argyle Street, Glasgow; secretary, Mr. T. B. Alexander. We understand that this firm has been formed into a limited company for purely family reasons.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—The Town Council has resolved that with the view of meeting the additional expenditure on plant, machinery, &c., in connection with the electric lighting undertaking, and the purchase price of the property at Dee Village recently acquired, an application be made for the consent of the Secretary for Scotland to the borrowing of the further sum of £22,000.

Aylesbury.—A deputation from the District Council has visited the electric lighting works at Harrow, Windsor, and Wycombe, and reports to the Council in favour of a municipal scheme.

Barrow.—The Town Council has decided to apply to the Local Government Board for leave to borrow £6,690, the balance of a loan applied for last year, and has instructed Messrs. Kincaid, Waller & Manville to report on the work of extension.

Birmingham.—An illustrated history and description of the Birmingham electricity supply works, with photos and short biographical notices of the members of the Electric Supply Committee, appear in the last issue of the *Birmingham Magazine*, which is a most excellently got-up art publication printed and illustrated in the best style. The issue is called an "Electrical Number."

Dublin.—The Local Government Board has requested the City Council to explain why the offer of the Tramway Company to supply electricity was not considered, before the Board comes to a final decision on the electric lighting scheme. A deputation from the Corporation, including Mr. Hammond, waited on the Board on Monday last for this purpose.

The electrical superintendent and city accountant have submitted reports to the Lighting Committee, showing that the output of the electricity works was 20,000 units greater in the quarter ending March 31st last than in the corresponding period last year, and the total revenue was £3,745, as against £3,167.

Evesham.—The Town Council is making inquiries about electric lighting with a view to its adoption in the borough. It is possible that considerable water-power may be derived from the River Avon.

The Doe Portable Electric Light and Power Syndicate is winding

that Messrs. Brown, Hoisting and Company's electrical coal trimming

Frome.—The Town Council has appointed Messrs. Medhurst and Kitchin, consulting engineers, to report on the electric lighting of the town.

Gloucester.—We understand that it has been found necessary to postpone the official opening of the Gloucester Electricity Supply Station, which had been provisionally fixed for the 24th inst. About the middle of June is said to be the probable date.

Guildford.—The Town Council threatens proceedings against the Electricity Works for emission of black smoke from the chimney shaft.

Hereford.—The Free Library has been fitted with an electric lighting installation, which was formally switched on last week.

Inverness.—A lively dispute has arisen in connection with the contracts for the electricity works. The progress of this municipal scheme has been constantly followed in these columns since July last, and we may recall the fact that the Town Council appointed Mr. Craven, of Edinburgh, to draw up plans and specifications, and to carry out the undertaking, on condition that he severed his connection with the Brush Company. The tenders having been received, the lowest, that of the Brush Company of £21,000, was accepted by the Council on March 14th, but as mentioned in our issue of the 27th ult., a hitch arose later on, and the matter was reopened. At a meeting of the Council on the 7th inst. the report of a Special Committee on the tenders and correspondence was considered. According to the *Inverness Courier*, the town clerk read a letter from Mr. Craven stating that he had gone into the tenders of the Brush Company and Messrs. Crompton & Co., and the final figures brought out a difference in favour of the Brush Company's tender of £794. A letter from Messrs. Crompton & Co. was also read as to the discrepancies between the figures in the engineer's report and analysis of tenders and their tender and subsequent letters, which they stated very materially affected their figures as compared with those of other tenderers. Mr. James Stuart, manager of the Haythorn Tubulous Boiler Syndicate, Glasgow, wrote stating that he understood there was a feeling amongst some members of the Council that their clerk had pledged himself in some way to get Haythorn boilers into the electric station in Inverness. Mr. Macdonald had never, directly or indirectly, met any member of the syndicate. He had said to Mr. Macdonald that he hoped their boilers would be considered on their merits. Describing a confidential arrangement between Mr. Craven and himself, Mr. Stuart stated that he had reduced his quotation to the Brush Company by £200 per boiler at Mr. Craven's request, and had quoted to Messrs. Crompton & Co. and Fowler's at £125 per boiler more than the Brush Company's quotation. After a preliminary squabble as to the question of allowing representatives of the firms concerned to remain in the Council room, Mr. Craven proceeded to reply to the points raised, remarking that it was within his discretion to use what communications from the firms he considered advisable, and that the alleged inaccuracies in the figures in his report were attempts at hair-splitting. In answer to Messrs. Crompton's complaint that the reduction they offered, if multipolar dynamos were used, was not reported, Mr. Craven said that on no consideration whatever would he admit machines of the kind into any contract! He refused to discuss what Mr. Stuart said. A discussion followed, in the course of which extraordinary feats were performed with the figures of the two tenders chiefly concerned. It was proposed and seconded that the Special Committee's report (that the Brush Company's offer be accepted) be adopted; but an amendment moved by the Provost, Mr. Maclean, in a vigorous speech, to the effect that the whole of the tenders, including those for separate sections of the work, be referred to the Electric Lighting Committee for consideration and report, was eventually agreed to. The Provost pointed out that Mr. Craven had not denied Mr. Stuart's statement (that he was recommended by the engineer to put the price of £200 more in their estimate for boilers to Messrs. Fowler and Crompton than in the estimate to the Brush Company, and that Mr. Craven gave as his reason that the Brush Company's estimate would be accepted in any case) and advocated the acceptance of a number of separate tenders, amounting in all to £17,182, nearly £4,000 less than the offer originally accepted. Considerable opposition was shown to the splitting-up of the contract, and the consequent divided responsibility, but as probably only three firms would share the work this drawback is not of great moment. The letters to which we have referred were published in full in the *Inverness Courier* of the 15th inst., and form very interesting reading; unfortunately, we are unable to reproduce them for lack of space. From a careful examination of the engineer's report on the various tenders, and of the correspondence, we cannot avoid the conclusion that one of the firms in question has good ground for complaint, while Mr. Stuart's letter describing the manner in which quotations were made to different firms discloses a state of affairs more instructive than edifying.

London.—Marylebone.—The Board of Guardians has resolved to adopt electric lighting for the infirmary.

Court of Common Council.—At the meeting on Thursday last week the Council had under consideration a report from the Streets Committee relative to the recent action in regard to the validity of the agreements with the City of London Electric Lighting Company. The Committee recommended that the City solicitor should be instructed to lodge an appeal against the order of Mr. Justice Farwell in the matter. Appended to the report was a further opinion from the counsel employed by the Corporation—Mr. Swinfen Eady, Q.C., Mr. Danckwertz, and Mr. Walter—who were of opinion that the judgment of Mr. Justice Farwell was erroneous, and for that reason should be appealed against. It seemed that the result of the judgment would go far beyond the immediate controversy in the case, and that, according to the learned judge, it was possible for any Aldermen and Councillors to become pecuniarily interested in contracting companies.—After a vigorous discussion, in which considerable opposition to the report was raised, the Council approved of the report by a large majority. The Corporation will, therefore, appeal against the judgment.

Islington.—The Vestry has resolved to appoint a deputation to wait on the London County Council with regard to the loans for which it applied some months ago.

Shoreditch.—The Vestry on Tuesday passed plans prepared by the surveyor for the erection of new stores and workshops at the electric lighting station, and an iron roof over the boilers in the destructor house. It was estimated that the cost would amount to £7,500.

Monte Video.—The *Review of the River Plate* says that the Monte Video electricity works which is run by the city authorities has now 18,930 incandescent 16-c.p. lamps connected up to its mains. The increase for 1899 was 4,086 lamps. The private lighting represents 10,251 lamps; the remainder represent those in service for public lighting.

Hull.—Some interesting particulars regarding the electric lighting undertaking were given at an inquiry conducted last week by Colonel W. R. Slacke, R.E., regarding the application of the Corporation for power to borrow £42,000 for the purpose of electric lighting extensions. Hull was granted its electric lighting order in 1890, and obtained its first loan for £25,000 in 1892, with which to provide an installation for the old town, or the town within the docks. These works were opened in January, 1893, with a total of 33 consumers. The number of consumers in the old town alone has since increased from 33 to 488. In 1897 a loan for £40,690 was obtained for the erection of additional works on the high tension system for the supply of the town generally. This involved the building of a new station, and further loans were obtained in 1899, the total borrowed being £128,490. The additional £42,000 is required for the purpose of extending the plant at the generating station, and of providing a sub-station on the Hessle Road, the number of consumers having increased to 1,326. On last year's working there was a balance of £1,924, which it was proposed to carry to the reserve fund, which, on March 31st last, amounted to £10,092. It is estimated that next winter there will be about 60,000 lamps of 8 c.p. burning at one time out of 90,000 attached. At the present moment the engineer has in hand over 2,500 new applications for the light.

Plymouth.—The electric lighting and traction undertaking was inaugurated in September last, and the accounts for the six months ending March 31st show that the receipts amounted to £3,278, and the working expenses to £3,167, leaving a balance of £111. As against this there are interest and sinking fund, and establishment charges amounting in the aggregate to £1,485, so that the net result of the six months' working is a loss of £1,374. This small adverse balance will, it is anticipated, be converted into a profit with the growth of the undertaking during the current year. In the meantime the tramways, which were continually worked at a loss while horse traction was in use, have made a small profit. The accounts for the year show that on the actual working of the tramways there was a profit of £4,739 as compared with £2,827 last year. The larger amount is sufficient to pay all the charges for sinking fund, interest, &c., and leave a balance of £298. This goes towards the extinction of the accumulated deficits of former years, which amounted to £8,692. As electric traction has only been in use for half a year, and only on one route, the financial result is considered very satisfactory.

Power Bills.—A requisition for the withdrawal of the petition in respect to the South Wales Bill has been deposited in the Private Bill Office of the House of Commons on behalf of the Aberdare and Aberaman Consumers' Gas Company. Petitions have been deposited in the Private Bill Office of the House of Commons on behalf of the following praying to be heard by counsel against alterations in regard to the above Bill upon the Committee stage being reached:—(1) Colliery proprietors, merchants, and others in and near Cardiff; (2) Incorporated South Wales and Monmouthshire Coal Freighters' Association; (3) Monmouthshire and South Wales Coalowners' Association; (4) Bridgend Chamber of Trade; and (5) Dowlais Iron Company.

The Pontypridd District Council considered the South Wales Electrical Power Distribution Company's Bill at a special meeting last week, and resolved to oppose the Bill in its entirety, and to apply to Parliament for electrical distribution powers for themselves.

A petition on behalf of the Cardiff Chamber of Commerce praying to be heard against alterations in regard to the South Wales Bill when the Committee stage is reached has been deposited in the Private Bill Office of the House of Commons.

Reading.—An explosion took place in a joint box belonging to the electric lighting company last week. As usual, no one was injured.

Ruthin.—The Town Council is considering the question of electric lighting for the town.

Salford.—According to a local paper Mr. Turner, the electrical engineer, has refused to comply with the Council's request that he should resign, and intends to commence an action against the Corporation for wrongful dismissal, if compelled to relinquish his post, as well as an action for slander against Mr. Haworth, the chairman of the Electric Light Committee.

Trade debits itself with two explosions and two lives, and other

River Avon.

Since Mr. Turner's retirement, Mr. F. A. Wilkinson has been appointed borough electrical engineer *pro tem.* Mr. Wilkinson was previously the assistant borough electrical engineer.

Shrewsbury.—The additions ordered to the electric light works are nearly finished, two new boilers having been fixed and a new dynamo and engine erected. The increase of energy sold last year, as compared with the year previous, was 45 per cent., and additional electric street lamps are to be erected.

Southampton.—The Local Government Board has consented to the borrowing by the Town Council of £50,655 out of £55,000 applied for, at the same time severely rebuking the Council for carrying out works to the amount of £34,088 in anticipation of the Board's sanction.

Stockport.—A Local Government Board inquiry was held last week by Mr. R. H. Bicknell, M.Inst.C.E., into the application of the Stockport Corporation to borrow £23,468 for the purposes of electric lighting. The present debt of the borough for electric lighting purposes was £24,331. The money for which the present application was made is to provide new feeders and mains, and additional boiler accommodation at the central station. Provision is made to a certain extent for the proposed electrical tramways. The accounts for the year show that the electric lighting undertaking has been a financial success.

Sunderland.—The Town Council has applied to the Local Government Board for sanction to borrow £4,500 for the purchase of land for electric lighting purposes. An inquiry was to be held on the 15th inst. by Colonel Luard.

Sydney (N.S.W.).—A report by Major Cardew on lighting Sydney by electricity has been adopted by the Council. The report states that it is essential that the work should be pushed on and extended as rapidly as possible, the demand for the light must be encouraged by every legitimate means, and the supply be kept ahead of the growth of the demand. Facilities in installation should be offered to the poorer classes of consumers, and the supply should be produced and distributed as cheaply as possible. An immense amount of money, the report states, has been wasted in England by starting electric supply on an insufficient basis owing to the desire to keep down initial capital. At Sydney Town Hall lighting should not cost more than £250 a year, against over £1,000 at present. The private supply would probably be 600,000 units per annum for the city alone, and after five years the public and private supply should reach 4,000,000 units a year. The cost is estimated as under:—Mains and street work, £60,000; generating plant, £50,000; buildings, &c., £25,000; wiring and fitting markets, &c., £3,000; total, £138,000; allowing for contingencies the expenditure necessary will be about £150,000. The engineer anticipates that after the second year the undertaking will become decidedly profitable, the mean price per unit obtained for private supply being at that time 4½d. After the fifth year the profit will be considerable, even with a reduction to 3½d. per unit.

ELECTRIC TRACTION NOTES.

Bath.—It appears that the negotiations which have been proceeding between the Electric Traction Committee of the Council and the promoters of the electric tramway scheme have arrived at a successful issue, and an agreement was drawn up for submission to this week's meeting of the local authority. The promoters are stated to be Sir James Sivewright, Mr. Leopold Hirsch, and others. The application for powers will be made jointly by the Council and the promoters, and rivals will be opposed. The promoters will pay the costs of the application, and of the last inquiry; and are to sell the works at a valuation at the end of 32 years, or after 14 years at fair market value; to pay a wayleave of £400 per annum for the first five years, £450 for the second five, and £500 a year afterwards. They will deposit £7,500 at 3 per cent. as a guarantee for carrying out the work, they will bear half the expense of street widening up to £2,000.

Birkenhead.—On 14th inst. workmen started upon the reconstruction for the electric service of the tramlines on the New Ferry route. The Cleveland Street route to the Docks has also been entered upon. Owing to the attitude of the existing company, no part of the routes where lines are at present laid can be touched until the expiration of the lease at the end of this year.

Birmingham.—The Public Works Committee was to visit Liverpool on Wednesday to inspect the city electric tramcar system.

Bolton.—At a meeting of the Bolton Tramways Committee last week it was decided that all drivers and conductors of electric trams should be licensed. Farnworth District Council were ordered to be informed that unless the defects in the electrical equipment in their tramways were not remedied to the satisfaction of the borough electrical engineer, without delay, the Committee would be obliged to withdraw the tram service thereon.

Canada.—The New York *Journal of Commerce* for 17th ult. states that the Council of Toronto and the Toronto Street Railway Company, of Toronto, propose to establish a system of electric railroads embracing all the country around Toronto between Brantford, Peterboro', and the Georgian Bay, with a radius of nearly 100 miles and involving a total mileage of 354 miles. The undertaking will involve an expenditure, it is calculated, of £570,000 for track and roadway alone. When the cost of wire, motors, cars, and power stations is included, it is expected that as much as £800,000 will be necessary to have the road and various branches equipped and in running order.

Dublin.—In the House of Commons last week Mr. Daly asked the President of the Board of Trade whether he was aware that numerous accidents have occurred to the public in consequence of the rapid rate at which the tramcars travel in Dublin; and whether he can state the reason why the order of the Board of Trade for speed indicators to be attached to the tramcars has not been carried out?

Mr. Ritchie: I am not aware that numerous accidents have occurred on the Dublin tramways from the cause mentioned, and the Tramway Company deny that such is the case. The delay in complying with the regulation as to speed indicators arises from the difficulty of procuring a trustworthy instrument. The question is under the consideration of some of the principal tramway promoters throughout the country, and I have every reason to hope that a satisfactory instrument may before long be available.

Hammersmith.—The Vestry has adopted a report by one of its committees regarding a plan submitted by the London United Tramways Company showing positions of lines, street poles, cableways, with manholes and feeder pillars, for the portion of their system between Young's Corner and the Broadway. The company asked for the Vestry's approval so as to permit them to proceed with their overhead system in King Street, Glenthorne Road, and Beadon Road, *pari passu* with the passage of their Bill in Parliament through its preliminary stages. The Vestry has approved conditionally.

Italy.—La Società delle Ferrorie del Mediterranea is preparing a scheme for the adoption of electric traction on the Rome-Frascati railway.

Kingston.—The Light Railway Commissioners will hold an inquiry on Tuesday, the 22nd inst., as to the expediency of granting the application by Messrs. Greenwood & Batley, for an order authorising a light railway for Kingston, Surbiton, and district.

Kirkcaldy.—It is stated that there is now every prospect that the Corporation will decide to take up the tramway and electric lighting scheme. It is understood that the special committee will urge this upon the Council at their next meeting.

Light Railways.—The Light Railways Commissioners have submitted to the Board of Trade for confirmation the Spen Valley light railway order, and the Barnstaple and District light railway order.

Liverpool.—The Parliamentary Committee of the Corporation has decided to oppose the application of the Overhead Railway Company to Parliament for further powers to enable them to agree with the Dock Board for the working of the traffic on the dock railway by electricity.

Northampton.—The Northampton Town Council and the Moulton Parish Council favour the construction of a light railway from Northampton to Kettering, *viâ* Kingsthorpe, Kingsley Park, Abington, Weston Favell, Moulton, Overstone, Sywell, Holcot, Harrington, Walgrave, and Broughton.

Paisley.—Under the agreement arrived at between Mr. Murphy and the Special Tramways Committee, both the Glasgow Corporation and Mr. Murphy will have running powers over the small portion of the line from the Cross eastwards, which will, under the Bill, fall into the hands of the Paisley Corporation. It is understood that opposition on the part of the various bodies has been withdrawn, and the principal opponents now will be the railway companies.

A conference took place on 11th inst. between the Tramway Committee and the agent of the Glasgow District Tramways Company, at which the agreement regarding the burgh tramways scheme promoted by the company was finally adjusted.

Plymouth.—A Board of Trade inquiry was held last week by Mr. A. P. Trotter respecting an application by the Corporation for power to borrow £20,000 for the extension of the electric tramways. It was explained that a loan of £18,000 had already been sanctioned for the overhead equipment and bonding the rails on the Compton section of the tramways, to which electric traction is now to be extended, and £20,000 is now required for the provision of the additional generating plant and on works in connection with the supply of current. Mr. J. H. Rider, the electrical engineer, gave evidence in support of the application, and stated that the line to be equipped was $3\frac{1}{10}$ miles of single track.

Russia.—Under the auspices of the Compagnie Générale de Traction et de l'Electricité, a company has just been formed at Silessin, Belgium, with a capital of £100,000, to be known as La Société de Tramways de Jaroslaw, Russia.

TELEGRAPH AND TELEPHONE NOTES.

Marylebone Vestry and the Telephone Service.—At a recent meeting of this Vestry, Mr. W. F. Pankhurst, C.C., objected to the proposal to grant permission to the National Telephone Company to lay conduits or pipes in various streets of the parish unless the company would promise to give the public inter-communication with the State service. The amendment he proposed in support of his views was lost, and the permission asked for was granted.

The National Telephone Company and its Wires.—At Bow Street, last week, the National Telephone Company were summoned, under the Overhead Wires Act, 1891, for failing to report the fixing of fresh wires to the local authority. Mr. Francis Robinson supported the summons on behalf of the Strand Board of Works, and Mr. Allsopp defended. Inspector Gregory, of the Board of Works, deposed that 180 wires had been erected by the defendant company between 34 and 35, Gerrard Street, and 79, Wardour Street, since June, 1898. With but one exception, no report had been made to the local authority of the fixing of these wires, for a very good reason. Mr. Allsopp contended that as the wires were not new, there was no need to report. The wires, he said, had simply been diverted by the removal of a third standard which used to exist between these two. Sir Franklin Lushington held that a report was required, and imposed a fine of £5 and £2 2s. costs. A second similar summons against the same company was dismissed, on the ground that the wire was simply a renewal of one which had already existed.

New Anglo-German Cable.—The *Times* Berlin correspondent says that a supplementary estimate has been laid before the Federal Council providing for the non-recurring expenditure of a sum of 2,000,000 marks on the construction of a new cable between England and Germany. There are at present four cables connecting the two countries, but the number of telegrams to be forwarded has increased by 32 per cent. since 1895, when the fourth cable was laid. The urgent necessity for a new connection is shown by the fact that the transmission of important telegrams is often delayed for several hours. In fact, the Cotton Exchange at Bremen has recently received telegrams from Liverpool *vid* New York instead of *vid* London, and has thus saved as much as two hours. The cables between Germany and England are also used for the transmission of telegrams between England and Austria. It is feared that the latter country will choose another route unless the connection is improved. The proposed new cable will join the Island of Borkum to Bacton in Norfolk. The cost will be shared by the English and German Post Offices.

Rubber Insulated Telegraph Cables.—In the report of the meeting of the Cuba Submarine Telegraph Company which appeared in our issue of last week, mention is made of the section of cable between Cienfuegos and Cape Cruz, which was laid in 1881, having proved so extremely weak that it was impossible to lift and repair. It is added that this was a cable which was laid on the deferred payment system, which was not originally made for the company but had done them very good service. It may be of interest to supplement this statement with the information that the section of cable referred to was made up of surplus portions of the Western and Brazilian and Para-Cayenne-Demerara cable, 1873, laid in deep water (upwards of 2,000 fathoms) for the greater part of the route between Santiago and Cienfuegos. This cable was laid in 1881, and the fact that it has been worked for nearly 20 years until the sheathing decayed, is a gratifying testimony to the lasting qualities of india-rubber core when properly manufactured, and show that india-rubber core as manufactured on the Hooper system is not affected by being laid in great depths, which point has been questioned more than once. We understand the cable laid by Messrs. Hooper in 1875 between the same points is still working most satisfactorily, and the insulation is very high.

Submarine Telephonic Communication.—The secretary of the Association of Chambers of Commerce of the United Kingdom has received the following communication from the Postmaster-General:—"The obstacle to the establishment of telephonic communication with countries other than France has consisted in the fact that it has not hitherto been found possible to devise a type of cable which would render conversation practicable across stretches of water much wider than the Straits of Dover. Various types of cables were devised and tested, and ultimately a cable, constructed on a new and apparently very promising principle, was laid between North Wales and Ireland, in the hope that the experience thus acquired would enable this department to make practical proposals for telephonic cables to Belgium and the Netherlands. Unfortunately, however, the experiment proved unsuccessful from a telephonic point of view; and, while the problem is still being closely studied, it cannot be said that a solution is in sight. In these circumstances the Postmaster-General is unable to hold out the prospect of the establishment of telephonic communication with the Continent generally at an early date, but he will continue to give the matter his best attention, and meanwhile he is negotiating with the French and Belgian administrations with a view to the establishment of a telephonic service through France to Brussels and Antwerp."

The Telegraph Wire Export Trade.—April proved to be a very active month as regards the exports from this country of telegraph wire and apparatus connected therewith. The value of the shipments during the month reached a total of no less than £257,089, as compared with £201,940 in the preceding month, and only £49,719 in April last year. The great activity which has ruled in this branch of the trade for this year is well indicated by the figures of the four months ending in April, which show an aggregate of £1,015,908, as against only £442,479 in the corresponding period of last year, and £313,671 in the first four months of 1898.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	... June 30, 1899 ...	...
Trinidad-Demerara (1891)	... Oct. 22, 1899 ...	...
Trinidad-Demerara (1871)	... Working badly.	
Mole St. Nicholas-Cape Haitien	... March 6, 1900 ...	...
San Domingo-Curaçoa ...	... May 6, 1900 ...	May 13, 1900.
Cayenne-Pinheiro	... Oct. 11, 1899 ...	...
Cayenne-Paramaribo ...	... Feb. 16, 1900 ...	...
Ceará-Maranham	... Feb. 20, 1900 ...	...
Pará-Maranham	... March 1, 1900 ...	...
Latakia-Cyprus	... June 20, 1899 ...	...
Manila-Iloilo	... Apl. 9, 1900 ...	...
Tarifa-Tangier	... Jan. 2, 1900 ...	...
Landlines.		
West Indies:—		
Haitien landlines ...	... Apl. 21, 1900 ...	...
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication beyond Aliwal North	Nov. 7, 1899 ...	...
Communication beyond Ladysmith (Natal)	Nov. 7, 1899 ...	...
Communication with all offices beyond Kimberley and Bloemfontein	Oct. 18, 1899 ...	...
Communication with all offices of Colombia beyond Buenaventura...	Feb. 22, 1900 ...	...
Communication "*vid* Hanekine" interrupted on Persian Territory	Feb. 24, 1900 ...	...
Ecuador landlines	Mch. 13, 1897 ...	...
Brasilian landlines, south of Macahe	Apl. 25, 1900 ...	...
Moulmein-Bangkok	May 7, 1900 ...	...

Underground Cables.—In the House of Commons last week, on the vote of £2,220,330 for the salaries and working expenses of the Post Office and telegraph services, Mr. Caldwell asked for information with regard to the laying of underground cables, remarking that Scotland, in time of storms, was frequently deprived of the means of communication by the blowing down of overhead wires. He did not ask that all wires should be underground, but he urged that there should be some underground for periods of emergency. Mr. Hanbury, in reply, said:—"As the hon. gentleman knows, underground wires have been laid between Birmingham and London. These new wires were laid in that direction because it is the course which the principal storms follow. That is a part of the country which suffers most from them; so that was the line which we chose first for the purposes of our experiment. And it is an experiment, because in these days, when there are both telegraphs and telephones, the telegraph and the telephone wires are laid in the same tube. There has been some doubt—a doubt which, I think, can only be finally settled by seeing the result from laying these wires between London and Birmingham—as to whether the telegraph and telephone service can be carried on effectively for any very great distance underground. There are reasons why, if that is successful, the Post Office will probably extend the underground service in other directions, no doubt down to the North. The hon. member, perhaps, knows that facilities for insulating the wires are now greater than they used to be, and a great deal more economical. Brown paper, I believe, is being used to a very great extent instead of india-rubber, and, while it is a great deal cheaper, it also lasts longer. Therefore, if this experiment between London and Birmingham proves successful I have no doubt the underground wires will be carried to other parts of the kingdom."

Sir C. Gull called attention to certain defects in the telephone service on the coast of Devonshire. Mr. Hanbury said the promise which had been given by the President of the Board of Trade and the Postmaster-General with regard to the matter would be carried out, and he did not know why it had not been done already. This vote was agreed to.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bradford.—May 24th. The Corporation wants tenders for two steam engines and dynamos of 1,000-KW. each. See "Official Notices" May 4th.

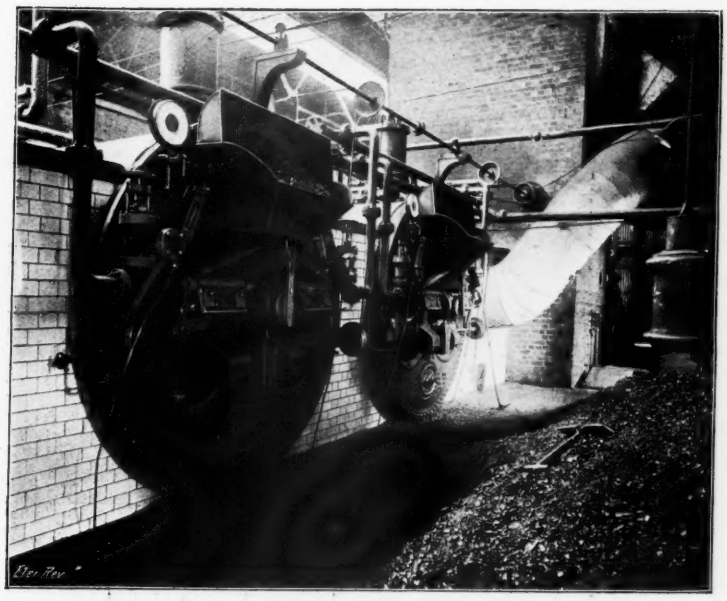
Bradford.—May 19th. The Corporation wants tenders for the supply of castings, forgings, and turned-work required for slipper brakes for electric tramcars. Drawings, specification, &c., at the Tramway Depôt, Horton Bank Top.

Bradford.—May 24th. The Corporation wants tenders for the supply of enclosed electric motors of 4½, 7, and 10 H.P., for a period of 12 months, from July 1st. See "Official Notices" May 11th.

(*Continued on page* 841.

COVENTRY CORPORATION ELECTRICITY WORKS.

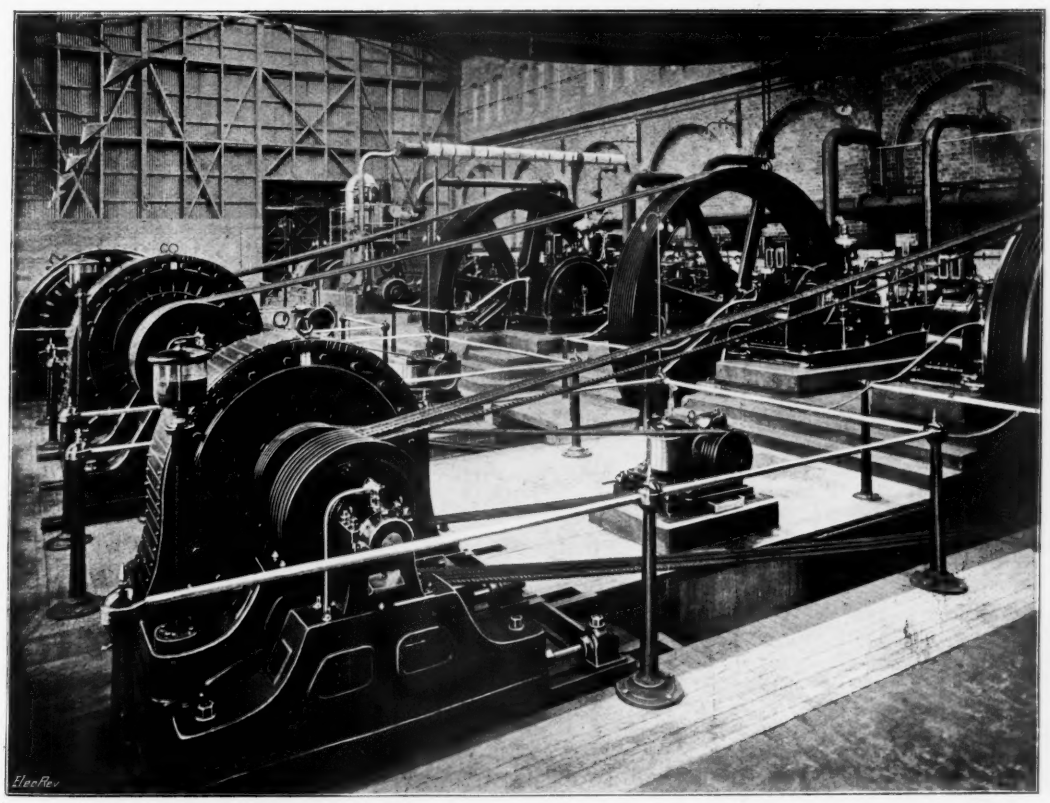
THE Coventry Corporation obtained a provisional order in 1891, but nothing definite was done towards carrying out any scheme until two years later, the Committee devoting the interval to making inquiries.



BOILERS AND INDUCED DRAUGHT FLUE.

Schemes were received from the Brush Company, Messrs. S. Z. de Ferranti and Messrs. Hammond and Co. (the latter with plant manufactured by Messrs. John Fowler & Co., Leeds), recommending a high tension alternating transformer system, with a station near the cotton mill; and one from the Electrical Power Storage Company, recommending a high tension direct current system, with sub-stations and storage batteries, the recommended a low tension direct current system, with or without storage batteries, the station being at Pool Meadow. Alternative schemes were also submitted by Messrs. Siemens Bros. & Co, one on the high tension alternating transformer system, the other on a system combining high tension alternating generation with low tension continuous current distribution. In comparing the estimates which accompanied these schemes, the Committee considered that the high tension alternating transformer system involved the smallest capital outlay, and was the best adapted to the needs of the city.

The Committee then invited those firms who had recommended a high tension alternating current system to submit amended estimates and specifications for a station capable of supplying current to about 4,300 8-C.P. lamps, and



GENERAL VIEW OF ENGINE ROOM.

generating plant to be at Pool Meadow, whilst the Electric Construction Company and Messrs. J. H. Holmes & Co. subsequently selected those of the Brush Company and Messrs. Hammond & Co., the cotton mill site being chosen for the

works; Mr. A. H. Preece was called upon to advise the Committee on the final selection of a tender, and recommended the acceptance of Messrs. Hammond and Fowler's scheme. Mr. Hammond having at that time decided to retire from contracting work, offered to act as consulting engineer to the Corporation, the contract being placed with Messrs. Fowler & Co. This suggestion was adopted by the Committee, and borrowing powers were sought from the Local Government Board for carrying out the scheme to the amount of £20,000. The work was proceeded with, the plant installed consisting of the following:—

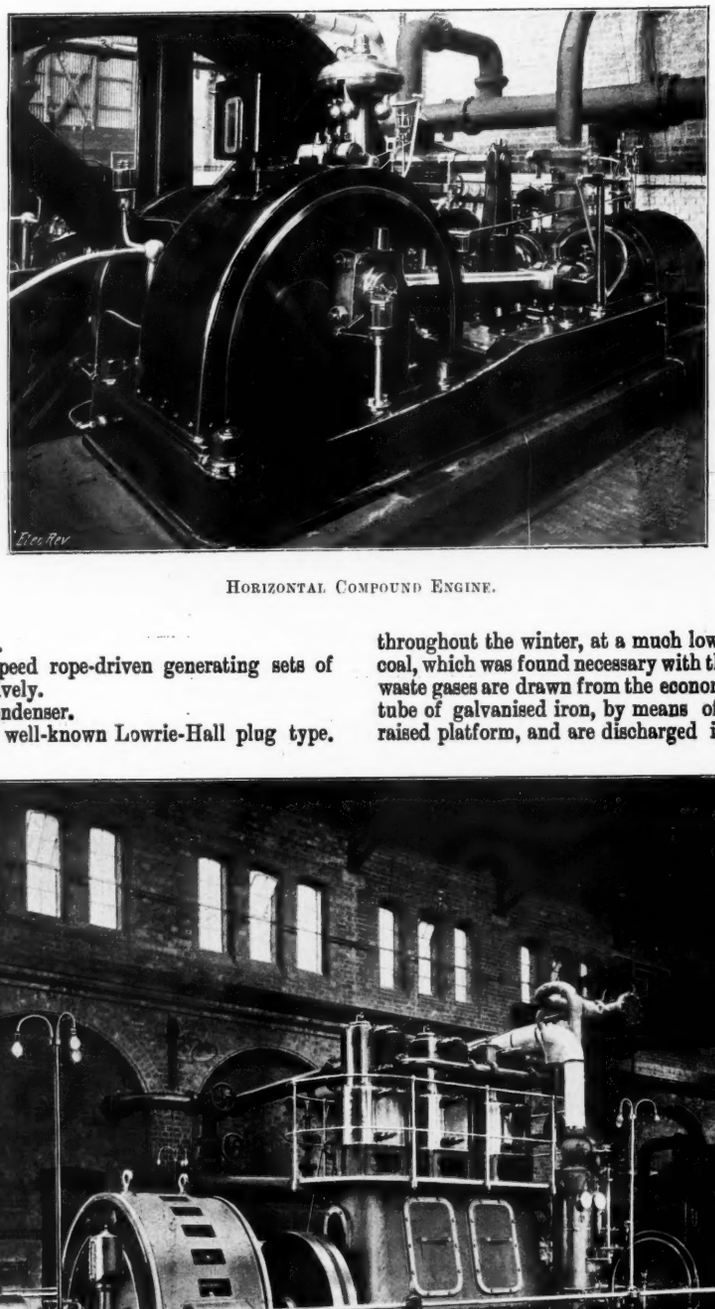
Two Lancashire boilers, each capable of evaporating 5,000 lbs. of water per hour.

A Green's economiser.

Two horizontal low speed rope-driven generating sets of 50 and 100 KW. respectively.

A Worthington jet condenser.

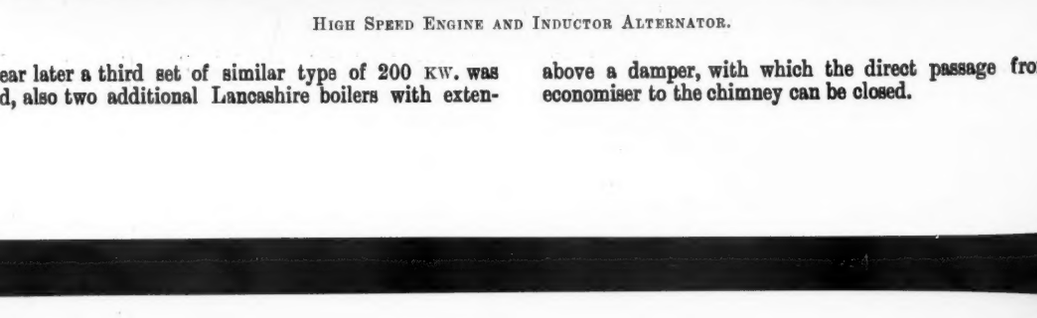
A switchboard of the well-known Lowrie-Hall plug type.



HORIZONTAL COMPOUND ENGINE.

A year later a third set of similar type of 200 KW. was ordered, also two additional Lancashire boilers with extensions to the economiser, &c. Lately a direct coupled Belliss-Fynn set of 300 KW. has been added.

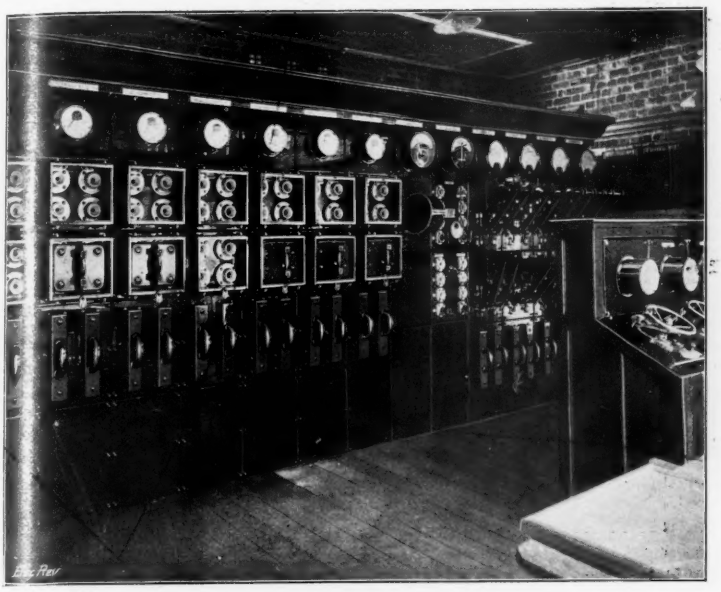
Two of the boilers are 30 feet × 7½ feet, and two 30 feet × 8 feet diameter; they are all fitted with Proctor mechanical stokers, driven by a small Tangye engine, which also operates the scrapers of the economiser. The boiler fittings are of Messrs. Hopkinson's manufacture. The chimney shaft, which is only 100 feet high by 5½ feet square, proving inadequate for the four boilers, the induced draught plant, which is shown in our illustration of the boiler house was added last year by the city electrical engineer, Mr. Ram; this has, we understand, already saved its first cost by enabling a local slack to be used throughout the winter, at a much lower price than the larger coal, which was found necessary with the natural draught. The waste gases are drawn from the economiser, through a draught tube of galvanised iron, by means of a fan mounted on a raised platform, and are discharged into the flue at a point above a damper, with which the direct passage from the economiser to the chimney can be closed.



HIGH SPEED ENGINE AND INDUCTOR ALTERNATOR.

Feed water is provided by means of two pumps, made by Messrs. J. & G. Weir and Messrs. F. Pearn & Co., respectively.

The steam piping consists of a single header supported on the boiler-house wall, from which smaller pipes are led off to the engines and boilers respectively; the exhaust pipe runs along the wall of the engine room, and is provided with two uptakes to the atmosphere. A Worthington jet condenser, built up with direct-acting steam pumps, is mounted near the small engine in the engine room.



Main Switchboard.

The horizontal engines are compound, with rope fly-wheel between the cranks. The governor is of the fly-ball type, acting on both cylinders by means of slot-links and expansion valves; an adjustable counter-balance, variable by hand while running, is fitted to the governors of the larger engines.

The rope-driven alternators are of the well-known Hall type, working at 2,000 volts, with revolving fields and stationary external armatures, and, like the engines, were made by Messrs. J. Fowler & Co.; the exciters are rope-driven from the alternator shafts.

The Fynn alternator is driven by a three-crank Belliss engine of the usual type, at a speed of 368 revolutions per minute, and is of the inductor type, made by Messrs. Easton, Anderson & Goolden under Mordey's patents. The output is 150 amperes at 2,000 volts, 87 periods per second. The exciter, a four-pole machine with barrel-wound toothed drum armature, is carried on the main bed-plate and driven by an extension of the shaft. An oil pump, belt-driven from the same shaft, forces oil through a strainer and maintains a head of oil in a stand-pipe; similar arrangements are provided for the lubrication of the horizontal engines, while the Belliss engine is as usual self-lubricating.

The engine room is traversed by a crane made by Messrs. Smith, of Rodley, capable of lifting 10 tons. On the end walls of the engine room are mounted two large incombustible resistances capable of carrying an artificial load of 50 KW., and on the middle of the side wall facing and in full view of the engines is fixed a signalling apparatus. The latter consists of a frame fitted with transparencies, behind each of which is a glow lamp; the lettering is as follows:—

1 2 3 4 5 6
SHUT DOWN
FASTER SLOWER
START STOP
RIGHT

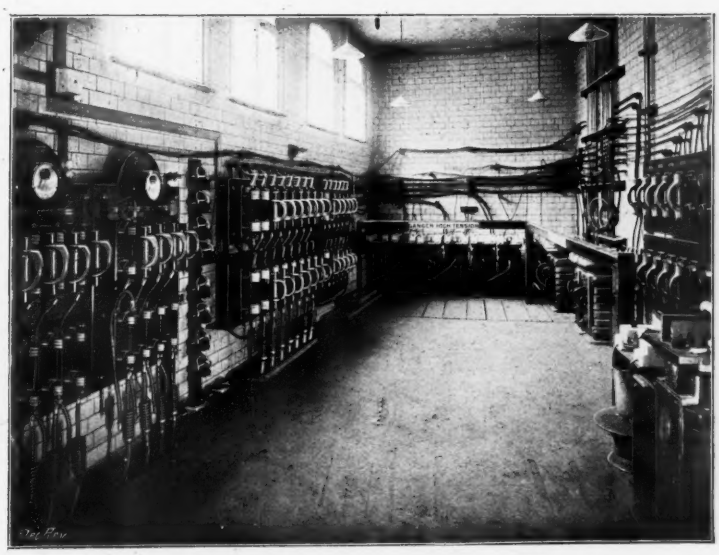
A warning bell is fixed beneath the apparatus, and the whole is operated from a plug-board on the switchboard gallery, by means of which any one or more of the glow lamps can be turned on and the corresponding signal illuminated. The device, which we saw in operation, worked admirably, and struck us as a capital arrangement.

Sufficient space is available for adding another 200 KW. set, and the end of the engine room being closed with corrugated iron, further extensions can readily be carried out.

The switch gear is placed in a gallery in the gable wall overlooking the whole of the engine room. The present switchboard has been erected within the last year, and is a single-pole board, the previous double-pole board, however, having been altered and incorporated in the new one. The work of changing from the old double-pole board to the present single-pole earthed outer was accomplished without shutting down the station, except for a few hours on Sundays.

There are 15 panels—nine feeders, four alternators, one upper bus bar and one lower bus bar. The feeder panels carry ammeter, two plug switches for the respective bus bars, and fuse; the alternator panels are fitted with ammeters and single-pole switches, one to each bus bar. On the other panels are mounted two Kelvin high tension voltmeters, Evershed synchronising voltmeters, and two sets of synchronising gear.

The whole of the switch gear was supplied by Messrs. John Fowler & Co., Leeds; the alternator switches are of their new type with automatic quick break, and have been tested successfully by breaking the circuit at 150 amperes and 2,000 volts. The alternator ammeters are of the dead-beat type manufactured by Messrs. Evershed & Vignoles.



Transformer Room at Sub-station.

The high tension concentric mains are worked with the outer conductor earthed at the switchboard, all switches and fuses being in circuit with the inner.

The regulating table is equipped with Fowler rheostats and Nalder voltmeters, and is placed some distance in front of the main switchboard, commanding a good view of the meters.

The supply is carried on by alternating current generated at 2,000 volts, 87 periods per second, transformed down to 200 volts for distribution on the two-wire system.

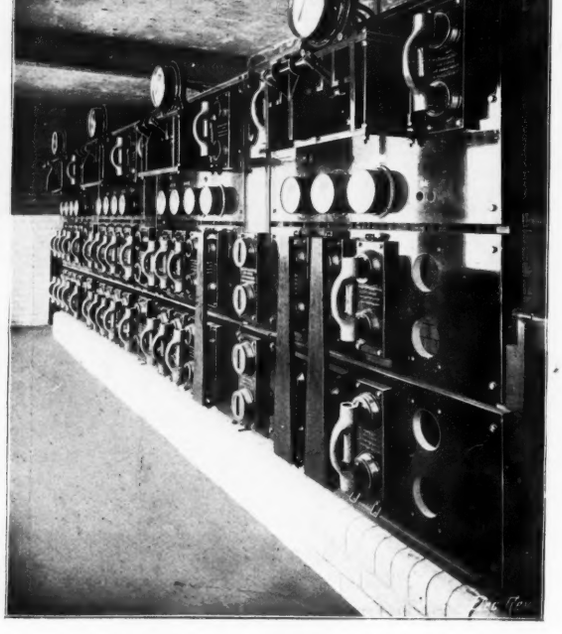
The distributing system originally consisted of separate vulcanised rubber insulated mains, drawn into iron pipes, and feeding transformers placed in boxes beneath the roadways, the transformers in turn feeding a low tension network at 100 volts. The low tension network consisted of 19/16 concentric cable inter-connected. The area originally supplied was the "compulsory area" scheduled in the provisional order, representing 1¼ miles only of streets in the business portion of the town, and did not extend into the residential districts. The whole of the mains, both high and low tension, with the surface boxes, transformer boxes, &c., were laid in the roadways.

The supply was commenced in November, 1895, with the not very encouraging outlook of seven customers connected to the mains. The method of charging was the "Brighton" system, at 6d. per unit for the first two hours' average use per day, and 3½d. for all beyond that amount. No public lighting was included in the original scheme.

Early in 1897 the rubber-covered mains commenced to fail, before they had been in use 18 months, and frequent short circuits occurred, putting the lights out throughout the system.

In 1898 the Committee recognised that in order to develop the undertaking it was necessary to largely extend the area of supply, and, upon the advice of the city electrical engineer, decided to re-model the existing system of distribution. At the same time it was decided to make a start with public lighting in some of the main thoroughfares. The scheme, which has now been completed, is briefly as follows :—

The high tension mains are concentric paper-insulated, lead-covered cables laid on the solid system. There are nine sub-stations, and three separate districts in residential parts fed by transformers placed in boxes beneath the pavement,



Feeder Board at Sub-station.

these boxes having been removed from their previous positions in the roadways. The largest transforming station is in West Orchard, in the centre of the town; nearly 50 per cent. of the output of the works is transformed at this station. The transformers used in this and one of the other sub-stations are the old 100-volt transformers which were previously in boxes beneath the roadways; they are now connected two in series, the present supply being at 200

Arc Lamp Posts.

volts. The upper floor of the West Orchard sub-station is utilised for a high tension switchboard, from which other sub-stations are controlled. Trunk mains from the works are led to this board, where they are split up through the switch gear to the mains leading to other sub-stations. Three of the sub-stations are below ground, and the remainder above ground; they are in communication with each other and with the works by means of telephones. The low tension distributing mains are not inter-connected between the sub-stations, and can all be disconnected by switches in their respective sub-stations; these mains provide a supply for over 9¾ miles of house frontage. The cables, both high and low tension, were supplied by the British Insulated Wire Company, of Prescot.

The sub-station switchboards, which were provided and erected by the Brush Electrical Engineering Company, consist of their well-known type of switch fuse mounted on polished slate base with a Nalder ammeter on each feeder. The feeder board at West Orchard sub-station, of which we give a view, provides for four main incoming feeders and 12 outgoing feeders; one of the latter is used for feeding the all-night arc circuits, the remainder go to five other sub-stations. Each incoming feeder, in addition to the switch fuses and ammeters, bears a double-pole main switch. In this room are also an Elliott recording voltmeter and the telephones communicating with other stations.

On the ground floor of the same building are the transformer, private lighting, and arc lighting switchboards, as well as the transformers themselves, of which there are 14 in all, each of 16½ KW.

The transformer board is on the right hand in our view of this room, and the transformers are ranged round the walls beneath. The eight low tension circuits are controlled by the further board on the left hand, and the arc circuits, of which there are eight, are brought to two boards in the left foreground, one for the midnight circuits, and one for the all-night lighting. Unlike most sub-stations, this one is well-lighted and ventilated, and ample room is provided for all requirements.

The street lighting, which consists of 40 arc lamps, was carried out by Messrs. Crompton & Co., the posts being made by Messrs. W. Macfarlane & Co., of Glasgow. The arc

lighting is supplied from separate mains at 200 volts, an economy coil being fixed in the base of each post; alternate lamps are on separate circuits, so that half of them can be turned out at midnight. The cables are carried into the base of the post, so that in case of a fault between any two lamps, tests may be made at the cable ends in the posts from lamp to lamp. The arc lamps are turned on from the West Orchard sub-station, whence also the early circuits are turned off. The extinction of the late circuits, the time for which, of course, varies at different times of the year, is accomplished from the works.

Our illustration of the arc lamp-post on Grey Friar's Green is also a typical illustration of Coventry, as it shows the three spires mentioned by Tennyson in his poem "Godiva."

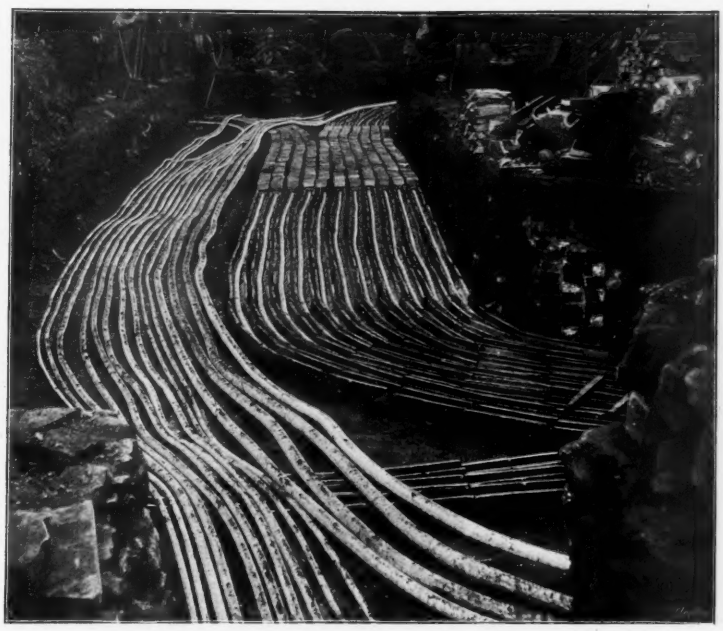
A year ago the Lighting Committee, in order to encourage new customers, decided to reduce the price charged, and to adopt a scheme of free wiring. Under the two-hour system of rebates previously in vogue, so very few customers obtained any rebate at all that there was much grumbling, and new customers could not be obtained owing to the prevailing idea that the price charged was very heavy. The price has therefore been reduced to 6d. for one hour and 3d. or half price for all beyond that amount.

This has made the difference that, whereas previously only 20 per cent. of the customers obtained a rebate, under the new charge there are only 20 per cent. who do not obtain it. The reduced charges, which came into operation in July last, have already had a marked effect in increasing the demand for current. The returns for the year ending March 31st last, which, however, are not yet published, show that the output, including that on public lighting, has increased from 115,000 to 230,000 units, the total costs per unit having at the same time fallen nearly 2d. per unit.

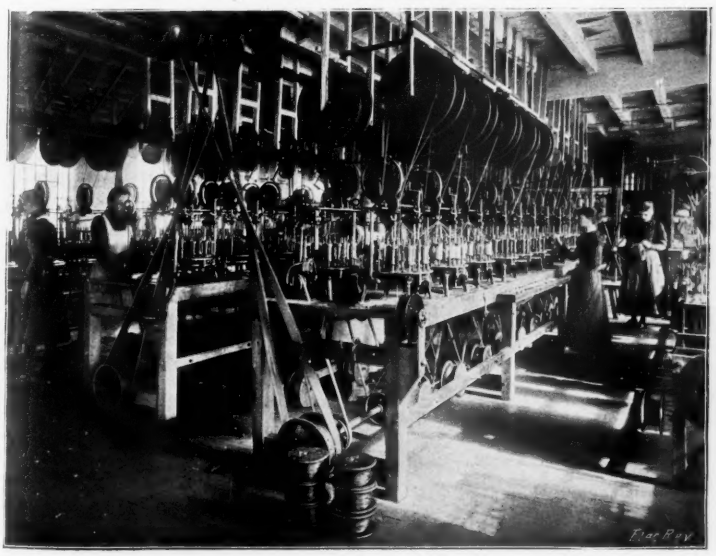
As the new charges and the street lighting only came into operation for part of the year, the full effect of the inducements held out to customers will not be seen until the end of another year's working.

The price charged to private customers is distinctly low, and only averages about 4¾d. per unit. The charge for street lighting is £20 per lamp per annum. Coventry is essentially a manufacturing town, there being a number of manufactories, both in the bicycle, ribbon, and the watch trades, requiring small units of power, and it is to be hoped that the improvements being made in single-phase alternating current motors will enable the station to supply power to a number of these.

The engine room plant, of which we give illustrations, has been made to the specification of Mr. Robert Hammond, while the cables, sub-stations, and arc lighting have been carried out by the resident engineer, Mr. G. S. Ram; Mr. H. Denton is chief assistant. We are indebted to Mr. Ram for kindly affording us facilities for photographing the works, and for supplying us with particulars of the apparatus.



Coventry.—Mains outside West Orchard Sub-station.



Silk Braiding Machines at Messrs. Rickard's.

MESSRS. RICKARD'S CABLE FACTORY AT DERBY.

The works which we describe below are of special interest, on account of the fact that the first length of silk-covered copper wire for use in electrical apparatus was manufactured therein.

The firm of J. & W. Rickard, from which the present firm is descended, was founded in 1853, and took up the business of covering wires a few years later; the manufacture of pure and vulcanised rubber insulated electric light wires and cables was commenced in 1892, while silk and cotton-covered wires for instruments, dynamos, telephones, bells, and blasting fuses, all come within the scope of the firm's operations.

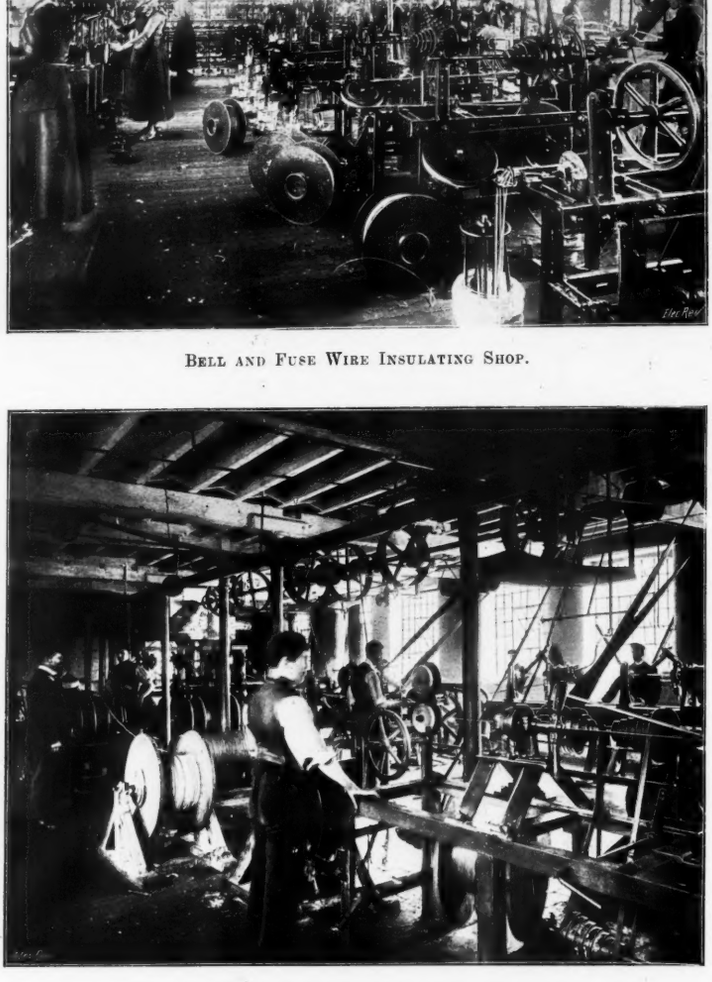
Of recent years, the business done has increased by leaps and bounds. The output of wires for blasting fuses, of which Messrs. Rickard were the first makers, now amounts to 160 miles per week, one customer alone taking 100 miles per week! About two years ago the firm appointed Mr. R. Dunscombe to the position of manager of the vulcanised rubber department, with the happiest results; within six months the sales were quadrupled, and the same held good for the first year. Messrs. Rickard claim that their products now stand in the front rank of insulated cables, and substantiate this by citing an order for £280,000 worth of vulcanised rubber-covered cable and flexible, which was recently placed with

them in connection with a contract for installing electric light in 100 north-country mills, as a consequence of the satisfactory results obtained elsewhere with their cables.

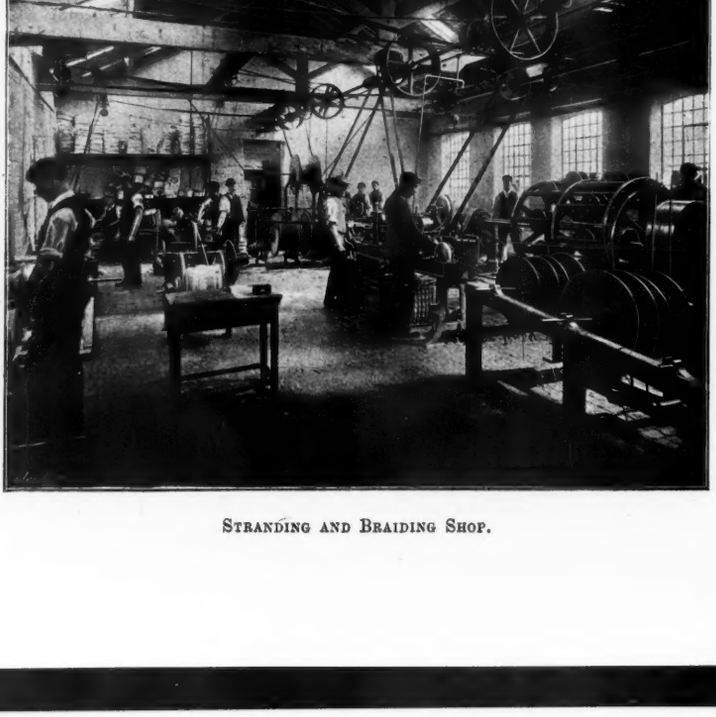
Our first view shows part of a plant consisting of 100 machines for braiding flexible with plain or coloured cotton and silk, those in the figure being of the last-mentioned description. On the same floor are a large number of machines for braiding and lapping solid wires with silk and cotton, for use in instrument making, dynamo construction, &c. The machines are of the usual type, made in America; they have been doubled in number quite recently, and still more are on order.

The next view is of a shop in which small conductors, such as bell wires, are lapped with pure rubber tape and paraffined cotton; in this room also twin fuse wires for blasting cartridges are manufactured.

Coming to the vulcanised rubber covering department, the third illustration shows machines for lapping cables and wires with rubber and tape:— The machine in the foreground is for lapping wires with a single layer of pure rubber. That in the window on the right is a double-headed machine, in which cables of all sizes, up to 3 inches diameter, are lapped with pure rubber, vulcanising rubber, and tape in one operation. In the middle distance is a longitudinal "trapping" machine, in which six cables, of too small size to be lapped in the ordinary way with vulcanising rubber, are



Bell and Fuse Wire Insulating Shop.



Rubber Covering Machines.

Stranding and Braiding Shop.

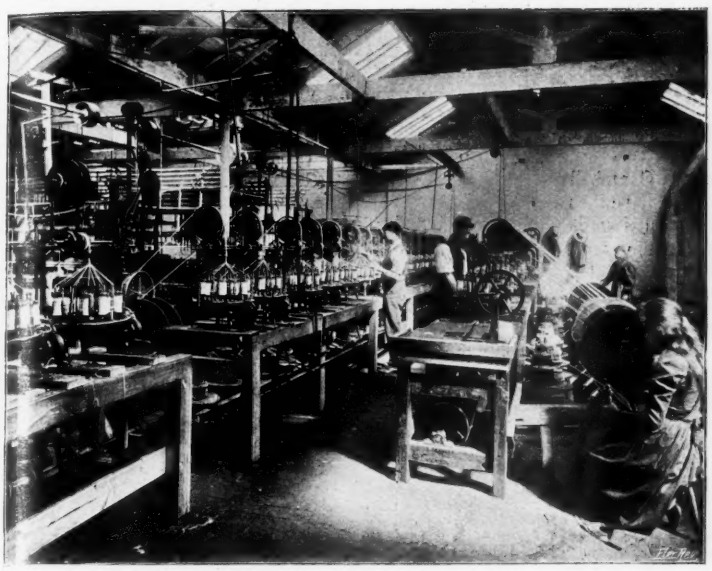
enclosed between two broad rubber bands, which are compressed upon the cables and cut between them, so that the edges adhere together, forming a watertight joint; two layers of rubber are applied in this way by this machine which, with the one last mentioned, is of the latest pattern, and quite recently installed. The machine on the left hand is for lapping rubber-covered cables with proof tape.

The next room illustrated contains, on the extreme right, but not shown, machines for braiding cables of all sizes, fitted with 16 and 24 spindles respectively. A Washington stranding machine, for laying up cables of any number up to 37 wires of the usual gauges is seen on the right of the view, while a trapping machine similar to that previously described occupies the centre. Next comes a single-headed pure rubber lapping machine for all sizes of cable, and two more stranding machines for 19 and 3 strands which are obscured by one of the operators. In the same room are various winding machines and a taping machine, while a taper is about to be put down which will turn out 40 miles per day of the smaller sizes of cable.

The last room which we illustrate contains 37 braiding machines for all ordinary sizes of wire, with 16, 20 and 24 spindles. These are practically new, but almost as many more are on order.

We ought to mention that the testing room is replete with the most modern instruments that Nalder Bros. and others could

supply. Messrs. Rickard do not themselves manufacture the rubber which is required for these operations; however, none



Cotton Braiding Machines at Messrs. Rickard's.

but pure Para rubber is used, and the materials of which the vulcanising rubber is manufactured are mixed according to their own specifications and recipes. All subsequent operations, including the vulcanising of the rubber, are carried on upon the premises—which, judging by the present rate of growth of the business, will soon have to be largely extended. Agencies are already established at London, Manchester, Bradford, Glasgow, and Dublin, and others will be added as opportunity arises.

Mr. Douglas Rickard (the sole proprietor) is to be congratulated upon the bright prospects before him, and upon the rapidly increasing demand for his goods, due to his energy and up-to-date methods, ably seconded by a thoroughly efficient staff.

"STELLITE" WORKS, ASTON, BIRMINGHAM (THE BRITISH ELECTRIC WORKS COMPANY, LIMITED).

If the cycle boom was not an unmixed blessing, it at least familiarised the workman with automatic machinery and tools and opened the eyes of his employer to the fact that for the profitable manufacturer of small accessories their adoption was a necessity.

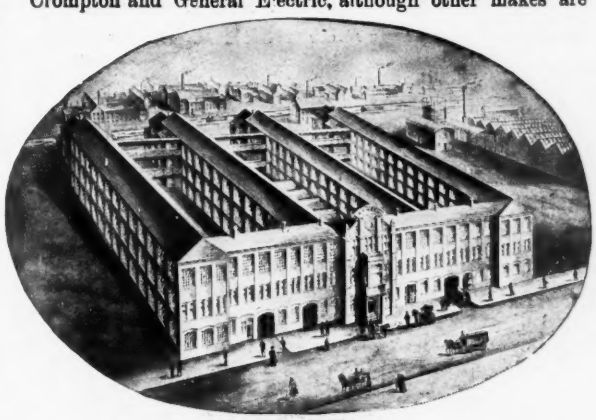
It is little more than a year ago that the British Electric Works Company was formed to take over certain works at Birmingham as they stood, and now instead of cycle parts the greater portion of the works is devoted to electrical fittings, although cycle components and other items, notably, Vickers-Maxim shells for the British Government, have a place.

The works, which we illustrate from photographs, have a frontage to Chester Road of 290 feet, the front being mainly occupied by the offices, packing, and model rooms, while the four branch buildings, each about 200 feet in length, are occupied by the factory proper, consisting of 12 shops; the space between the two centre blocks is roofed over and affords ample storage.

Outside the works proper are the brass foundry (an iron foundry is being added), the Dowson gas producer, and the power house. In the power house there are four Crossley gas engines developing about 350 H.P. These drive by belting three Crompton dynamos, two of 340 amperes and one of 600 amperes, and one General Electric dynamo (600 amperes) running at 110 volts. The switchboard is conveniently arranged for distributing, and a glance at the ammeter shows how carefully the work in the various shops has been apportioned, the variation in the readings being very small. A 4 H.P. motor-driven fan drives air through the factory; the air is cooled by water spray in summer, and warmed in winter.

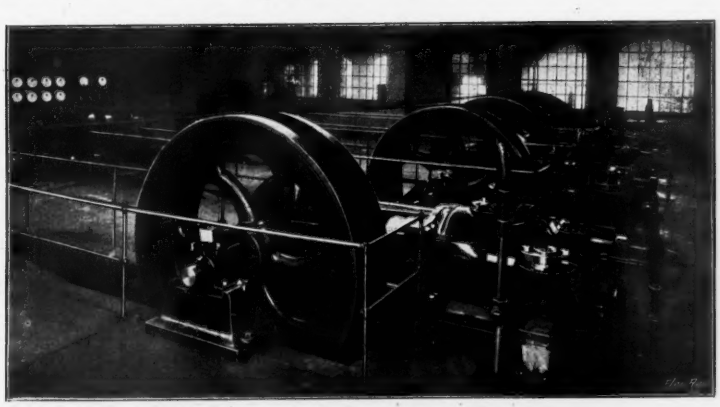
To describe each individual shop would be to quote a catalogue of machine tools. Suffice it to say, that the best Continental and American practice is adopted. In the shop we illustrate, the tools are arranged in *echelon* to allow of a longer feed without waste of space by the rod or tube feeding in from behind the preceding machine.

In only a few cases are separate motors used. The power required by individual machines being small, it has been found more economical to have a single 25 H.P. motor driving lines of shafting, but where heavier work is in hand, a separate motor of requisite power is employed for each machine. A range of Swiss machines turning out small brass work is a case in point, each machine taking, we should say, less than $\frac{1}{8}$ H.P. The motors are principally Crompton and General Electric, although other makes are



"Stellite" Works.

in use. In the polishing room small Crompton motors are fitted with a long shaft, on each end of which a grinding wheel or polishing bob is fitted.



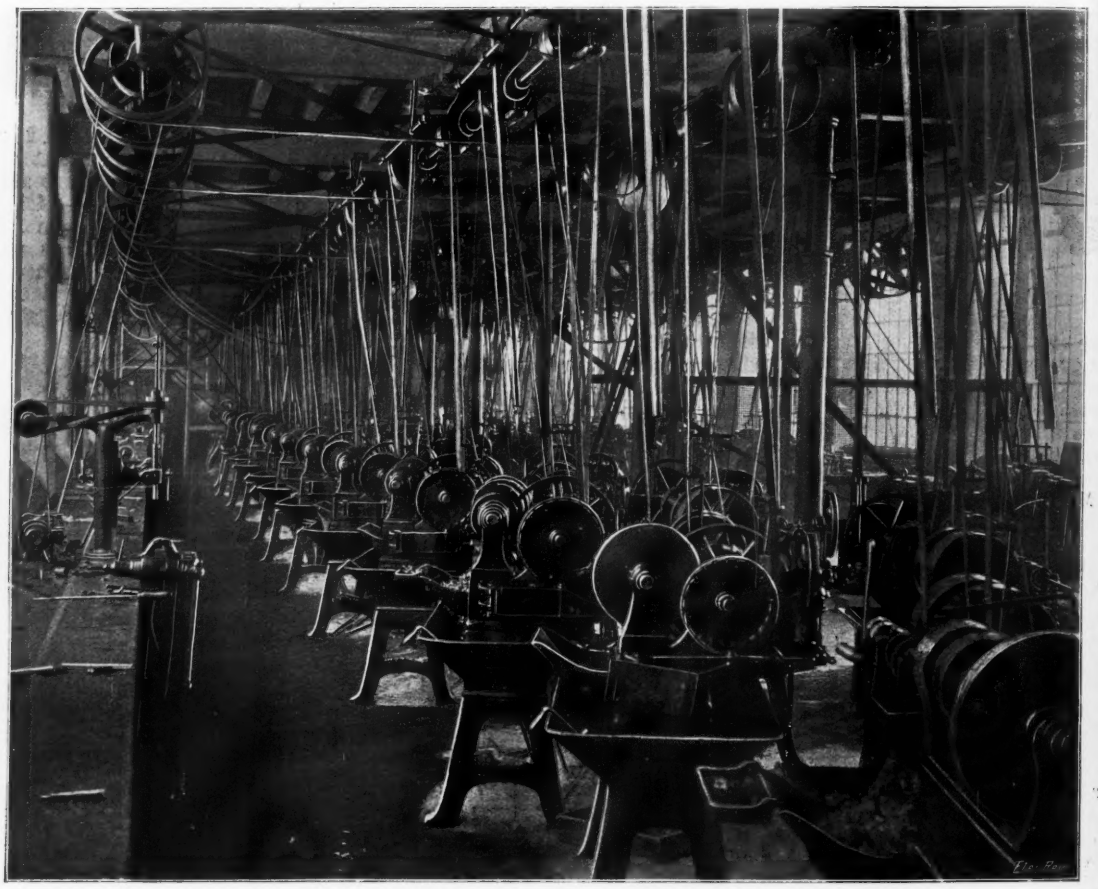
Gas Engines and Dynamos at the "Stellite" Works.

When describing some of the products of this firm some few months ago, we referred to their claim that everything was made in their own works, of British material, and by

British labour. "Where do you get your porcelain?" we asked. "At our own works at Hanley," was the reply. This is an advantage to which few, if any, fittings makers could lay claim.

The firm does a considerable amount of other work, but our interest goes no further than the electrical fittings, and for the manufacture of these we can only say that the place appears to be admirably adapted in every way.

Electric Light Wires and Dust.—Mr. A. A. Campbell Swinton recently wrote to *Nature* as follows:—"I believe that the collection of dust upon electric light wires and fittings is generally attributed to air currents, due to thermal causes, the same thing occurring, to some extent, with hot-water pipes. Recent experience has, however, convinced me that in the case of electric light conductors, electrostatic attraction is really the chief factor, particularly where the supply is at 200 volts from the street mains. In my office here I have several electric light cords strung across the ceiling. They are all exactly similar and under the same conditions, except that some of them have the switch in the negative and some in the positive conductor. The former gather dust to an extraordinary degree, and now, after a few months' use, have become quite an eyesore. The latter are practically as clean as when first put up. As is well known, the negative conductor of a street supply tends always to earth itself, and, as a matter of fact, in my case I find that the negative of my supply from the Westminster Company is almost at earth potential. The positive, on the other hand, is nearly 200 volts above the potential of the earth. In this lies obviously the cause of the phenomenon. The wires which have the switch in the negative are nearly at 200 volts potential above the earth whenever the switch is off, while those which have the switch in the positive are at zero potential in these circumstances. Of course, when the switches are on, all the cords are under similar conditions, one conductor in each being nearly at 200 volts above earth, and the other at about earth potential. No doubt it is when the switch is off, in the case where it is in the negative conductor, that the accumulation of dust takes place. Having regard to the comparative lowness of the 200 volts potential, from an electrostatic point of view, the rate at which the dust accumulates on the cords is most surprising, and this is my reason for thinking it worth while bringing the matter to notice."



One of the Machine Shops, "Stellite" Works.

A Solder for Aluminium.—"Many mechanics find it difficult," says the *Practical Engineer*, "to solder aluminium satisfactorily, either to itself or to other metals. A United States patent for a solder for this purpose was recently issued to Charles B. Thwing, of Galesburg, Ill. It is thus described in the specification by the inventor:—'It is very desirable that a solder for aluminium should melt at a low temperature, should adhere readily and permanently to the aluminium, and form a smooth, white surface, which will not discolour or disintegrate when exposed to water or to air containing moisture. I have found that an alloy of tin, zinc, and bismuth, and particularly one in which the tin is in excess of the other metals, meets these requirements in a very high degree. I prefer to use 30 per cent. or less of zinc, 5 per cent. or less of bismuth, and 65 per cent. or more of tin. I do not, however, limit myself to these proportions, as other proportions may be employed. My solder works well on brass, copper, nickel, iron and other metals, with zinc chloride as a flux. My solder is made, preferably, by melting the ingredients together in the desired proportions, and it may be applied to the metals to be joined in any known or preferred manner.'"

CONTRACTS OPEN.

(*Continued from page* 832.)

Bradford.—May 31st. The Corporation wants tenders for a coal-conveying apparatus and hoppers, also ash-conveying apparatus at the electricity works. See "Official Notices" to-day.

Bridgwater.—June 7th. The Council wants tenders for the supply of boiler house plant, engine house plant, dynamos, pumps, switchboard, mains, lamp-posts, accumulators, meters, crane, &c., for electricity supply. See "Official Notices" May 11th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Crewe.—May 26th. The Council wants tenders for the supply and laying of about 25,000 yards of three-core cable, and 500 lampholders and reflectors for adapting the existing lamp-posts for electric lighting. See "Official Notices" May 11th.

Crewe.—June 11th. Tenders are wanted by the Corporation for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting (separate quotations for arc and incandescent lighting) the same. Tenders to Town Clerk.

Devonport.—May 25th. The Corporation wants tenders for electric light and traction feeders, distributors, boxes, &c. See "Official Notices" May 11th.

Dundee.—May 22nd. The Town Council wants tenders for the supply of copper bonds for the city tramways. See "Official Notices" May 11th.

Dundee.—May 31st. The Council wants tenders for the overhead equipment of four tramway routes. See "Official Notices" to-day. Another notice invites tenders for coal and electricity meters.

Durban.—June 29th. The Corporation wants tenders for overhead equipment for (*a*) about 16 miles of single track, including poles, overhead trolley wire, distribution boxes; (*b*) 22 double-deck motor cars; (*c*) steam and electric generating plant, including three 250-KW. generators, boilers, condensers, cooling towers, switchboard, &c. See "Official Notices" to-day.

Edinburgh.—May 21st. The City Council wants tenders for elevators and conveyors for coal and ashes at the McDonald Road electricity station. See "Official Notices" May 11th.

Glasgow.—May 19th. The Corporation wants tenders for the supply for one year of india-rubber covered and lead-covered branch cables; and carbons. See "Official Notices" May 4th.

Glasgow.—June 12th. The Corporation wants tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each, for the electricity department. See "Official Notices" May 11th.

Great Yarmouth.—May 31st. The Electric Lighting Committee wants tenders for the supply of coals for the electric light station for a period of 6 or 12 months from June 1st next.

Grimsby.—June 1st. The Corporation wants tenders for arc lamp-posts and brackets. See "Official Notices" to-day. Another notice invites tenders for a number of electric meters.

Hull.—May 24th. The Electric Lighting Committee is inviting tenders for a supply of best double-screened South Yorkshire hard steam coal to their Dagger Lane Works, from June 1st to November 30th.

Italy.—July 14th. The Municipal authorities of Maddalena (Sardegna), are inviting projects and tenders until July 14th, for the electric lighting of the public streets of the town. Particulars may be obtained from, and schemes and tenders are to be sent to, Il Municipio di Maddalena (Sardegna.)

Leeds.—May 28th. Tenders are wanted for two or three 630-KW. two-phase generators, and one or two sets of surface condensing plant, for the electricity works. See "Official Notices" May 4th.

London.—May 22nd. The Central Electric Supply Company, Limited, invites tenders for (1) two 1,200-I.H.P. Willans engines and three-phase H.T. generators (direct-coupled); (2) six three-phase H.T. motors direct-coupled to L.T. continuous current generator; (3) switchboards and connections. Specifications, &c., at the office of Prof. Kennedy. As to conditions and general particulars see our "Official Notices" April 20th.

London.—June 1st. The City Corporation Streets Committee invite proposals for the hire of an electrically-driven dust cart. See "Official Notices" April 20th.

London.—The Postmaster-General invites applications for specifications for galvanised iron strand stay wire for telegraph purposes. See "Official Notices" May 4th.

London County Council.—June 16th. The Council invites tenders for an electric lighting and power installation (excluding generating plant) telephones, fire alarms, &c., at the Horton Asylum, near Epsom. See "Official Notices" to-day.

Newcastle-on-Tyne.—June 1st. The New Tramways Committee wants tenders for switchboards, underground feeders, and pumping apparatus. See "Official Notices" May 11th.

Partick.—June 8th. The Commissioners want tenders for a dust destructor with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. See "Official Notices" to-day.

Rathmines.—May 21st. The Urban District Council invites tenders for the wiring of the out-houses at the rear of the Town Hall, the Fire Brigade Station, and the Public Library. Specifications, &c., from the Clerk of the Council, Town Hall.

Russia.—The municipal authorities of Vladivostock are at present inviting proposals for the electric lighting of the town, and also for the construction and working of an electric tramway.

South London.—June 2nd. The South London Electric Supply Corporation wants tenders for the complete installation of 3,000 lights on the premises of 500 consumers in any part of the area of the company's supply, and for the installation of two arc lights on the premises of any consumer in the same area. See "Official Notices" to-day.

Southampton.—May 28th. The Corporation wants tenders for a water-tube boiler, with steam and other pipes, and sundry ironwork for the electricity works. See "Official Notices" May 11th.

Spain.—July 7th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7th next, for the concession for an electric tramway from the Puerta de Hierro (Madrid) to Aravaco and Pozuelo. Some particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Sutton Coldfield.—June 21st. The Corporation invites tenders for water-tube boilers and other steam plant, pipework, three steam dynamos and boosters; batteries, switchboard, overhead traveller, mains and conduits, arc lamps and posts, and station lighting. See "Official Notices" to-day.

Tanat Valley.—June 5th. The directors of the Cambrian Railways Company are prepared to receive tenders for the construction of a light railway, about 15 miles long, 4 feet 8½ inches gauge, commencing by a junction with the branch of the Cambrian railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans, specification, and quantities obtained, on payment of £1 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald Road, Oswestry.

Tunbridge Wells.—The Corporation wants tenders for a number of Shallenberger (Westinghouse) 1897 pattern ampere-hour meters. See "Official Notices" May 4th.

Walthamstow.—May 29th. The District Council wants tenders for arc lamps, posts, accessories, and glow lamps on existing gas standards. See "Official Notices" May 11th.

Worksop.—May 23rd. The District Council wants tenders for steam dynamos, balancers, boosters, and motors; Lancashire boilers; pipes, economiser, condenser, and feed pumps; switchboard; accumulators; cables, joint boxes, arc lamps and posts; overhead traveller for electricity works. See "Official Notices" May 4th.

CLOSED.

Bermondsey.—The Vestry has accepted the lowest tender submitted for the erection of a chimney shaft in connection with the electric lighting and dust destructor works at £2,581.

Birkenhead.—The Corporation has accepted the following tenders for plant for the Craven Street generating station:—Boilers, economiser, and mechanical stokers, Messrs. Tetlow Bros.; steam dynamos, Siemens Bros. & Co.; condensing plant, re-cooling tower, and feed pumps, Klein Engineering Company; accumulator batteries and booster, E.P.S. Co.; overhead travelling crane, Marshall, Fleming & Jack.

City of Adelaide, Australia.—The Electric Lighting and Traction Company of Australia, Limited, have placed the order for the electrical generating plant for the above city with Messrs. D. Bruce Peebles & Co.

Keighley.—Mr. J. M. Smythe, the borough electrical engineer, informs us, with reference to a statement made on page 790 of our last issue, that no tender for constructional steel work has yet been accepted by the Council. The name mentioned was recommended, but for certain reasons the recommendation was withdrawn.

London.—The Shoreditch Vestry on Tuesday considered the following tenders for the supply of cable:—

Siemens Bros. & Co.	£655 2 3
Henley's Telegraph Works Company	634 0 0
Glover & Co.	598 5 10
British Insulated Wire Company (accepted)	582 14 8

The Vestry also had under consideration the undernoted tenders for the supply of feeder panels for the switchboard:—

The Electric Construction Company (accepted)	£455 0 0
Veritys, Limited	456 0 0
Evered & Co.	457 0 0
General Electric Company	497 0 0
Crompton & Co.	555 0 0
Nalder Bros. & Thompson	575 0 0
Brush Electrical Engineering Company	715 0 0

Norwich.—The Town Council has accepted the tender of Messrs. G. N. O. Mann & Co., of Norwich, to supply the electric installation at the Technical Institute for £575.

Sheffield.—The City Council has accepted the tender of Messrs. John Brown & Co., Limited, Atlas Works, Sheffield, to supply and erect three marine boilers of the type already supplied, for the sum of £8,550 for the three boilers, the first boiler to be delivered and completed within six and a half months from date of order, and the second and third boilers to be completed six months later. The boilers will be fitted with Messrs. Bennis's mechanical stokers at a further cost of £100 each boiler. They are for the electricity works.

Whitechapel.—The District Board has accepted the tender of Mr. William Griffiths for the construction of the first portion of the electrical power house for the sum of £15,774.

Wolverhampton.—The Town Council has accepted the tender of the Bedford Engineering Company for the supply and erection of a 20-ton overhead crane at the electric light works.

FORTHCOMING EVENTS.

Friday, May 18th.—At 8 p.m. The Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "A Short Review of the Motor Car Industry," by Basil H. Joy and Charles H. Rush.

At 9 p.m.—Royal Institution. "The Structure of Metals," by Prof. J. A. Ewing.

Saturday, May 19th.—At 7.30 p.m. Manchester Society of Junior Electrical Engineers. Meeting at Engineering Laboratories, Whitworth Street, Manchester. Paper by T. E. Herbert, on "The Application of Accumulators to Telegraphy and Telephony."

Institution of Electrical Engineers.—Students' Visit to the India-Rubber, Gutta-Percha, and Telegraph Works, Silvertown.

Monday, May 21st.—At 8 p.m. Society of Arts. (Cantor Lecture.) Prof. Vivian B. Lewis on "The Incandescent Gas Mantle and its Use." (Lecture III.)

Wednesday, May 23rd.—At 7.30 p.m. Institution of Electrical Engineers. Students' Meeting. Paper on "Dynamo Design and Construction," by Mr. R. Waite, student.

Thursday, May 24th.—At 8 p.m. The Institution of Electrical Engineers. Annual General Meeting at the Society of Arts, John Street, W.C., for members, associate members, and associates only, to receive the annual report of the Council, and statement of accounts and balance sheet for year ending December 31st, 1899.

Friday, May 25th.—At 5 p.m. Physical Society meeting at the rooms of the Chemical Society. Agenda:—(1) Experiments illustrating the Aberration called Coma, by Prof. S. P. Thompson, F.R.S.; (2) "Notes on the Measurement of some Standard Resistances," by Mr. R. T. Glazebrook, F.R.S.; (3) "On the Strength of Ductile Materials under Combined Stresses," by Mr. J. J. Guest.

NOTES.

Science in Relation to Art and Industry.—At the annual banquet of the Royal Academy on Saturday evening, Sir Norman Lockyer's name was coupled with science in the toast of "Literature and Science." Sir Norman Lockyer replied on behalf of "Science," and concluded his speech as follows:—"We are in the face of a struggle for existence in which we know full well that only the fittest will survive. How are we going to carry on the struggle? What are our weapons? Our first line of defence in this direction can only consist of our universities and our teaching centres. Have we enough of them? We know already that we have not enough of them, because we have already lost several important engagements in these industrial battles. Are there no means by which we can judge of their sufficiency? In relation to non-peaceful international struggles, in which also defeat has to be guarded against, a clear and universally approved policy has been enunciated; this is, that the future of our Empire—an Empire the real unity and strength of which are developing under our eyes at this moment—can be secured if we see to it that our first line of defence, our fleet, shall be equal in strength to the fleets of two other possibly contending powers. The second answer then, I think, is that this principle should be applied to our first line of defence in those industrial conflicts, the results of which are much more enduring. Do our teaching and research centres at present outnumber in the same proportion, as do our ships, those of any two nations which are actually contending with us in peaceful enterprise? And, also, are they equally efficient in every respect? I believe—and I know that this view is held by many representative men of science—that until our universities, our science schools, our art schools, and our technical institutions bear the same relation, both in number and efficiency, to those of other nations as do our battleships, cruisers, and small craft, we shall not be justified in regarding the future of the Empire with that freedom from care which is the attribute of a strong man armed." The full report of the speech appeared in last week's *Nature*.

Municipal Excitation.—According to the *Western Mail* there is a good deal of electricity in the air in regard to the management of the electrical supply at Cardiff. There is an Electric Lighting Committee and an Electric Tramways Committee, and the friction between the two produces another supply of electricity for which no suitable use has yet been found. Evidently, to vitreous and resinous electricity, we must now add acrimonious electricity.

High Speed Railways.—Whatever may be the Parliamentary fate of the high speed electric railway between Manchester and Liverpool, no one could deny that the designer of the system has displayed remarkable pertinacity. We hold it to be no small achievement to convince a body of North Country business men that the proposals possess some possibilities. That the scheme has met with pretty wide acceptance and strong support is shown by the evidence recently tendered before the Parliamentary Committee. From an electrical point of view, the scheme is one of prodigious interest; and Mr. Behr, who has so earnestly and persistently pleaded the cause of the monorail system for many years past, deserves success. The experience gained at the Brussels Exhibition probably justifies the view that it will be possible to attain a speed of 120 miles per hour with a single car, but there are many considerations besides those of mere speed to bear in mind. The system is designed for the operation of single cars at intervals of every 10 minutes, but though, in this respect, it bears some slight resemblance to a tramway, there is the important difference, that while the tramcar obtains what we may term the intermediate passenger, only through passengers are to be carried on the Liverpool and Manchester railway. In fact, the system relies on merely carrying passengers at an abnormal speed between Liverpool and Manchester; there being no goods traffic, and no local service. The ordinary railway man would prognosticate failure from this very fact; but the promoters of the electric line hold this to be a strong point in their favour. In many respects we should be delighted to see the scheme of the Manchester and Liverpool Railway carried through, but we cannot close our eyes to the fact that the competition with the already existing lines will be somewhat severe; probably for that reason the experiment will be interesting. At the same time there are three railway systems running between Liverpool and Manchester, each of which strives to give a service which is remarkable for its efficiency and punctuality. The schedule time for the express service is usually 40 minutes; but we believe that the Lancashire and Yorkshire, with their new type of locomotive, have contrived to reduce even this; and it is highly probable that some still higher speeds could be effected if it were thought desirable.

Fire.—On Thursday morning a fire broke out in the subway of the Central London Railway, but the damage appears to have been confined to carpenters' tools, benches, &c., and to the subway works generally, and did not in any way affect the railway.

Appointments Vacant.—An assistant superintendent is wanted for the Indian Telegraph Department, at R·3,600 a year. A headmaster is wanted for the Government of India Industrial School, at Lucknow, at 300 rupees per month. See our "Official Notices" to-day.

The Southport Corporation wants a tramways manager at £150 per annum. See "Official Notices" to-day.

Narrow Escape of the Paris Exposition!—According to the Paris edition of the *New York Herald*, a short time ago "the Galerie de l'Electricité in the Champ de Mars was the scene of an outrage which might have had most serious consequences. The engineers on duty at the large dynamo belonging to the Lahmeyer Company discovered that someone had introduced a large handful of gravel into one of the lubricators. This led to the firing of the bearings. This was fortunately noticed in time, otherwise the machine, which develops 1,500 H P. and weighs 360 tons, might have exploded." A shocking mental picture of immense volts and foot-pounds flying about the "galerie" arises before us as we read; no wonder the Sublime Porte objects to the importation of explosive dynamos, with bearings which may be fired by any spiteful young Turk with a handful of gravel!

Congresses at Paris.—The *Scientific American* says that among the numerous congresses which are to be held this year in Paris in connection with the Exposition, the following list will, no doubt, be found convenient for reference:—

July 9—13.	Automobiles.
„ 16—18.	Steam Apparatus; Surveillance and Security.
„ 19—25.	Applied Mechanics.
„ 23—28.	Photography.
„ 23—31.	Applied Chemistry.
„ 27—Aug. 1.	Electricity as applied to Medicine; Radiography, &c.
Aug. 6—11.	Chemistry.
„ 6—11.	Technical, Commercial, and Industrial Education.
„ 6—11.	Mathematics.
„ 6—11.	Physics.
„ 18—25.	Electricity.
Sept. 3— 5.	Gas.
„ 20—29.	Railroads.

High Voltage Transmission Leakage.—The *Electrical World* abstracts a paper read before the Chicago Electrical Association by Mr. Budd Frankenfeld, pointing out that while mathematical analysis shows that the three-phase system of electric power transmission is the most economical, this does not hold when the working limit of voltage is approached. "The two-phase, four-wire system with interconnected apparatus has six leakage paths—two at the limit of pressures and four at 71 per cent. of this pressure; the three-phase system has three leakage paths, each at the limit of pressure; the two-phase, four-wire system with independent circuits has only two leakage paths, both at the limit of voltage, while the single-phase system has but one path, at the limit of voltage. Considering the above systems from this standpoint, the single-phase has the greatest advantage, the two-phase system with independent circuits coming next, and for the third place there is but little difference between the three-phase and two-phase interconnected systems."

The Volta Centenary.—We have recently received the full report of the proceedings at Como last September in commemoration of the centenary of Volta and the discovery of the pile. We have already printed full abstracts or translations of some of the more important papers, particularly Prof. Righi's address on the life of Volta and his note on the theory of the pile. Several other papers were of very great interest, and, in particular, one by Prof. S. P. Thompson on "Magnetic Images and their Application to the Theory of Motors with Rotating Fields," and an address by Prof. A. Volta on the proposed publication of the collected works of his distinguished ancestor. Volta's connection with the Royal Society, and the fact that some of his earliest and most prominent discoveries were communicated to that body, should interest Englishmen in the scheme.

Building Trades' Gift.—The special matinée at the Theatre Royal, to which we drew attention in our last issue, proved a great success, and was heartily supported; the net profit is estimated to be about £3,000, which will be devoted to the formation of a maintenance fund. The executive desire to express their gratitude to the many artists and other helpers who were associated with the matinée, and especially to the director, Mr. Arthur Collins.

Cheap Manufacture.—In a recent article on the modern machine shop occurs this passage:—"The use of the hollow spindle conduces to great economies. If repetitive work under, say, 2 inches in diameter has to be turned, then it is cheaper to turn it from a bar passed through a hollow spindle of a turret lathe than to make separate forgings, even though the latter should be stamped in dies. The material cut away and wasted is of much less value than the cost of forging or of chucking each single piece." It is then stated that if the hollow-spindle method is not practicable, it is cheaper to saw off pieces from a bar with a power hack saw than it is to forge the pieces approximately to shape. This passage embodies the prevailing machine-shop idea of manufacture, an idea that rejects, or, rather, that never absorbs any notions so old-world as durability. It is cheaper to build up a door frame by putting the uprights against the top piece than it is to mortise the frame together, and it is cheaper to saw out curved pieces for furniture or carriages than to steam and bend a natural pole to shape in order to preserve the fibre continuity. By the narrowest of machine shop ideas a piece of machinery is simply a collection of wheels, spindles, bearings, and frames of a shape and disposition according to a drawing, but from an engineer's point of view not a structure to be proud of. The cutting of pieces from the solid bar is by no means always sound practice. Where the part cut out is for other reasons larger than mere strength would demand, it may be sound practice to cut such piece out of the solid, but in other cases it is not good practice to carry out a system of manufacture that introduces a discontinuity of structure. The drop forging is preferable to the machinery to shape out of the solid bar, just as the crankshaft bent out of the round bar is sounder than the cranked shaft cut out of the solid. The enormous failure of locomotive cranked axles cut from the solid forging demonstrated that the random forging was essentially weak, and too frequently, in the piling of an iron shaft, little or no endeavour was made to so dispose the pieces as to bring about even an approximation to continuity of fibre direction in the finished shaft. Where large numbers of pieces must be made alike and turned from the bar, it should not be impossible to forge such bars to approximate shape in a rolling mill—an operation that would be more rapid than drop forging, and that would preserve some continuity of fibre. The rule of the machine shop has become supreme, and has resulted in accuracy of workmanship with materials not necessarily the best for the end that the machine is intended to accomplish, but only best for the rapid production of the machine itself, irrespective of any thought for its duty. It is certain that the manufacturing method has become permanent, but it is not certain that its present crude disregard of materials and principles will remain, as it is to-day, an embodiment of pure selfishness in respect of ease for the manufacturer only.

Insurance of Electricity Works.—The Shoreditch Vestry are issuing to the other London local authorities a circular letter inviting them to appoint two delegates to attend a conference at the Shoreditch Town Hall on June 7th to consider the question of municipal insurance. The letter points out that the Vestry

> have recently had under consideration the large premiums exacted from them and other local authorities for insurance, especially for electricity works, and as they now pay £450 per annum for insurance, the sum total of municipal insurances of local authorities in London must have reached an amount sufficiently large to warrant the establishment of some scheme for mutual insurance with every prospect of success. The Corporations of Glasgow and Nottingham obtained in 1898 power to insure their own property against fire, and a combination including the large number of municipal properties in London would seem to offer special chances of success and reduction of the present premiums. The Vestry have accordingly decided to call a conference of metropolitan local authorities to discuss this question and the best means of carrying into effect some such scheme, either by establishing a central office for the purpose, or by asking the London County Council to undertake the administration of a common fund.

Eastern Extension, Australasia and China Telegraph Company.—With a view to partly meeting the expenditure necessary in connection with the new Cape-Australian cable, the directors have decided to issue to the shareholders the unissued balance of 50,000 ordinary shares at a premium of £3 per share, or at £13 each.

Personal.—Mr. W. J. Sowter, assistant electrical engineer at Ealing, has been appointed chief assistant engineer to Mr. Gilbert S. Ram, of the Coventry Electricity Supply Works.

The Harrogate Town Council has raised the salary of the electrical engineer (Mr. Wilkinson) to £400 per annum.

Mr. C. B. Holdsworth, chief clerk and accountant to the Bradford Corporation electric lighting department, has been appointed chief clerk and book-keeper at the lighting station of the Shoreditch Vestry.

We note that Mr. L. J. B. Wall, of the firm of Messrs. Splatt, Wall & Co., electrical engineers, West Australia, is at present in this country on business connected with his firm's interests.

General Post Office.—Mr. J. W. Curra has been appointed a first class technical officer in the Engineer-in-Chief's office.

Fire at the Paris Exhibition.—A fire broke out in the Exposition on Tuesday afternoon in the Chateau d'Eau, and the whole of the electrical apparatus for the illumination of the fountains was destroyed. The official inquiry has shown that the fire was not brought about by a short circuit, but probably by imprudence on the part of a workman. The repair work is being pushed forward by day and night, and may be completed within a fortnight.

British Institution of Draughtsmen.—At the half-yearly meeting of the Council of this Institution, held in London on the 14th ult., it was decided to accept the resignation of Mr. J. Gillaird, of London, as hon. secretary and treasurer. Mr. C. L. Groundwater, of Manchester, and Mr. J. F. Wakeham, of Newcastle, were unanimously elected hon. secretary and hon. treasurer respectively in his place. The thanks of the members of the Institution are due to Mr. Gillaird for the very able and courteous manner in which he has discharged his duties. At the same meeting it was decided to alter the title of the society from "British Association of Draughtsmen" to that of "British Institution of Draughtsmen."

American Boiler Insurance.—The Hartford Boiler Insurance Company reports that in the past year over 112,000 visits have been made by its inspectors, when 221,706 boilers were examined, of which 85,804 were examined both internally and externally and 12,800 dangerous defects discovered, while 779 boilers were condemned. Nearly 5,000 defective pressure gauges were found, and 203 boilers with no gauges at all. The company is evidently one of large size, and much more of a monopoly than any English company. Assuming merely one annual thorough inspection, there appear to be at least 90,000 boilers under its charge. It seems likely, too, from the list of defects that its work is very arduous, and that it probably deals with boilers that are by no means so safe as the general run of boilers under our English Societies.

100-Volt Arc Lamp.—The Continental Electric Company, of Boston, advertises an arc lamp taking a current of 4·5 amperes, in which 100 volts are absorbed by the arc itself. It is said to give 40 per cent. more light than the enclosed arc at 80 volts per unit of power consumed, while the length of the arc is double that of the ordinary 50-volt lamp. These figures are said to be taken from experiments made by a very high authority, whose name, however, is not disclosed. Nothing is said as to the extent of the gyratory action of the arc round the points of the carbon.

A Century of Chemistry.—A course of lectures on "A Century of Chemistry at the Royal Institution," is being delivered at the Royal Institution, by Prof. Dewar. In his first lecture Prof. Dewar said that the Institution's scientific history began with Sir Humphry Davy, and paid a high tribute to his singular boldness and originality in devising experiments, though it had to be admitted that in his earlier days he did not always show corresponding caution in drawing conclusions from them. The *Times* account says that a crucial experiment of his regarding the nature of heat was exhibited. Heat was at that time regarded as an entity which entered into combination with matter, and certain phenomena were explained as being due to the liberation of the specific heat of bodies. By grinding two pieces of ice together *in vacuo*, Davy showed that they melted, although the specific heat of the water produced was greater than that of the ice, thus establishing the truth of his own view that heat was a mode of motion. He entered with great eagerness into the study of gases, to which the discoveries of Priestley and others had given prominence, and showed astonishing boldness, if not temerity, in finding out their physiological action by experiments on his own person. Thus, having demonstrated the properties of nitrous oxide, now extensively used by dentists, he pushed his experiments with carbonic oxide so far as to put his life in imminent peril. This curiosity was the more remarkable, because he had left on record a very disparaging estimate of physiology, the ultimate object of which he declared must for ever remain unattainable. The same contempt for danger was shown in his experiments upon chloride of nitrogen, which the loss of an eye, and almost of his life, did not deter him from resuming as soon as he could return to work. Davy's electrical work was next referred to, and some interesting pieces of his rudimentary apparatus were exhibited. The galvanometer had not then been invented, but Davy detected exceedingly feeble currents by the aid of an instrument which the lecturer showed in operation, and which was in some respects equally efficient. He also repeated Davy's ingenious experiments in electrolysis with Davy's own apparatus, and showed how with very simple appliances he attacked problems and arrived at conclusions which subsequent research had only confirmed and amplified.

An Electrolytic Interrupter for Weak Currents.—Rzewuski (*Ann. der Phy.*, p. 614, 1900) has discovered that the Wehnelt interrupter can *be made to work* satisfactorily with 12 accumulators by directing a stream of dilute sulphuric acid against the active electrode. The accumulation of gas bubbles on the electrode is thus prevented, and a frequency of 450 breaks per second has been obtained. The dilute acid is introduced by a glass tube fitted to slide in the lid of the cell, so that the distance of the nozzle from the electrode can be varied. The glass tube is connected to a closed vessel containing the acid, from which it is forced by an air-ball.

Municipal Trading.—The following are the names of peers to join with a Committee of the House of Commons on this subject:—The Earl of Crewe, Viscount Hampden, Viscount Peel, Lord Windsor, and Lord Rothschild.

NEW COMPANIES REGISTERED.

Monarch Motor Company, Limited (65,893).—This company was registered on May 10th, with a capital of £250,000 in £1 shares, to adopt an agreement with E. Jessuran, and to carry on the business of oil, gas, and electric motor manufacturers, engineers, machinists, electricians, rubber manufacturers and merchants, carriage builders, cycle manufacturers, &c. The first subscribers (each with one share) are:—W. H. Edwards, 69, Leadenhall Street, E.C., clerk; A. Campion, 17, Philpot Lane, E.C., merchant; H. Labban, 17, Stavordale Road, Highbury, N., clerk; J. Q. Ivens, 40, Darenth Road, N., clerk; F. J. Todd, 18, Darville Road, N., secretary; A. Gates, 24, New Oxford Street, W.C., merchant; and A. E. Goff, 32, Museum Street, W.C., auditor. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, 1,000 shares; remuneration as fixed by the company.

T. Coulthard & Co., Limited (65,885).—This company was registered on May 8th, with a capital of £75,000 in £1 shares, to acquire the business carried on at Preston, Lancashire, as T. Coulthard & Co., and to carry on the business of spindle and ring makers, machinists, motor vehicle makers, boiler makers, iron and brass founders, tool makers, electrical and general engineers, machine makers, &c. The first subscribers (each with one share) are:—T. Coulthard, Cooper Road, Preston, engineer; J. H. Toulmin, Cooper Road, Preston, engineer; T. Coulthard, jun., Cooper Road, Preston, engineer; A. Coulthard, Sandgate, St. Anne's-on-the-Sea, engineer; E. Leach, 262, St. Paul's Road, Preston, manager; H. Bingham, 279,

New Hall Lane, Preston, traveller; and J. J. C. Fletcher, 13, Lark Avenue, Penwortham, cashier. The number of directors is not to be less than two nor more than seven. The first are the first three subscribers; qualification, 1,000; remuneration £50 each per annum, or more, according to profits. Registered office, Cooper Road Works, Preston, Lancashire.

Meldrum Brothers, Limited (65,918).—This company was registered on May 12th, with a capital of £125,000 in £1 shares, to acquire and take over as a going concern the business now carried on by J. J. Meldrum, T. F. Meldrum and J. W. Meldrum at Atlantic Works, City Road, Manchester, under the style of "Meldrum Brothers," and to carry on the business of ironfounders, furnace manufacturers, mechanical and electrical engineers, makers of mechanical stokers, refuse destructors, steam jet apparatus and other engineering specialities, &c. The first subscribers (each with one share) are:—James J. Meldrum, Atlantic Works, City Road, Manchester, engineer; John W. Meldrum, Atlantic Works, City Road, Manchester, engineer; Thomas F. Meldrum, Atlantic Works, City Road, Manchester, engineer; William K. Meldrum, Atlantic Works, City Road, Manchester, engineer; William Mortimer, 21, Claremont Grove, Didsbury, Manchester, engineer; John P. Davies, 39, Albion Street, Old Trafford, Brooks Bar, Manchester, cashier; and Thomas Collinge, 69, Stamford Street, Old Trafford, Manchester, cashier. The number of directors is not to be less than three nor more than 10. The first are James J. Meldrum (chairman), Thomas F. Meldrum and John W. Meldrum; qualification, £500; remuneration, £1,500 per annum, divisible. Registered office, Atlantic Works, City Road, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Scarborough Electric Supply Company, Limited (37,569).—This company's annual return was filed on March 16th, when the entire capital of £50,000 in 5,000 shares of £10 each had been taken up; £9 per share has been called up, resulting in the receipt of £45,000, in addition to which £3 has been paid in advance of calls.

Oldham, Ashton, and Hyde Electric Tramway Company, Limited (55,318).—This company's annual return was filed on March 26th, when the entire capital of £80,000 in 4,000 ordinary and 4,000 preference shares of £10 each had been taken up and paid in full.

Potteries Electric Traction Company, Limited (57,968).—This company's annual return was filed on April 19th, when the entire capital of £400,000 in 20,000 preference and 20,000 ordinary shares of £10 each, had been taken up. £10 has been called up on each of 20,000 preference and 13,334 ordinary shares, resulting in the receipt of £333,340. £66,660 is considered as paid on the remaining ordinary shares.

National Telephone Company, Limited (15,066).—This company's annual return was filed on April 12th, when 15,000 first preference, 15,000 second preference, 221,716 third preference, and 445,587 ordinary shares were taken up out of a nominal capital of £6,000,000 in 15,000 first preference, and 15,000 second preference shares of £10 each, and 250,000 third preference, and 590,000 ordinary shares of £5 each. All the first, second, and third preference, and 490,000 ordinary shares have been taken up, £10 has been called up on each of the first and second preference, and £5 on each of 221,716 third preference, and 445,587 ordinary shares, resulting in the receipt of £3,636,516. £363,485 is considered as paid on 28,284 third preference, and 44,413 ordinary shares.

Charing Cross and Strand Electricity Corporation, Limited (29,122).—This company's annual return was filed on March 26th, when the entire capital of £350,000 in 70,000 shares of £5 each, had been taken up and paid in full.

Amazon Telegraph Company, Limited (44,532).—This company's annual return was filed on March 19th, when the entire capital of £250,000, in 25,000 shares of £10 each, had been taken up and paid in full.

South London Electric Supply Corporation, Limited (50,932).—This company's annual return was filed on March 30th, when the entire capital of £325,000, in 65,000 shares of £5 each, had been taken up. The full amount has been called up on each share, resulting in the receipt of £324,780. £220 remains in arrears.

Telegraph Construction and Maintenance Company, Limited (1,147 C.)—This company's annual return was filed on March 21st, when the entire capital of £448,200 in £12 shares had been taken up and paid in full.

Direct Spanish Telegraph Company, Limited (6,732 C.)—This company's annual return was filed on April 26th, when 12,931 ordinary and 6,000 preference shares were taken up out of a nominal capital of £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each; £5 has been called up on each share, resulting in the receipt of £94,655.

Norwich Electricity Company, Limited (30,694).—This company's annual return was filed on April 4th, when the entire capital of £100,000 in 10,000 shares of £10 each had been taken up and paid in full.

London Electric Supply Corporation, Limited (24,959).—This company's annual return was filed on April 18th, when 111,000 ordinary and 49,840 preference shares were taken up out of a nominal capital of £850,000 in 200,000 ordinary shares of £3 each and 50,000 preference shares of £5 each. The full amount has been called up on each share, resulting in the receipt of £582,200, in addition to which £3,740 has been paid on 1,950 forfeited shares.

SUPPLY STATION ACCOUNTS.

Cardiff Corporation Electricity Accounts.

The accounts of the Cardiff Corporation electricity undertaking for 1897 and 1898 show a rather disappointing result, and it is to be hoped that as Mr. Applebee has now been given a more reasonably free hand in the management of the business, he may be able to show an improvement in the 1899 accounts when we come to deal with them. To summarise the position, it seems that a reduction in price for supply has been made when only a trivial profit resulted from the working of the undertaking. The effect has been to increase the output by some 50,000 units, but the gross return from sale of current remains practically unaltered. Owing to the rising market for coal, &c., the costs have not come down, so that the extra units sold have cost proportionately the same per unit to produce. Coupled with this is the unavoidable increase in interest and sinking fund charges, so that the result is a loss of about £1,000, of which £500 is attributable to extra gross cost of production for the same revenue, and £500 (or the other half) is due to the extra interest payable on loans.

GENERAL STATEMENT.

	1897.	1898.	Increase.
Total capital expenditure ...	£62,440	£71,028	£8,588
Number of units sold	357,193	405,234	48,041
Maximum load in kilowatts ...	375 KW.	420 KW.	45 KW.
Gross revenue	£7,026	£7,056	£30
Gross profit ...	£2,576	£1,944	−£632
Average price per unit sold ...	4·64d.	4·10d.	−·54d.

The revenue statement shows very clearly that an inopportune time has been chosen for reducing the price. The gross revenue from sale of current has increased by the remarkable figure of £5, but the price per unit has fallen by over a halfpenny, being nearly $4\frac{3}{8}$d. in 1897 and $4\frac{1}{10}$d. in 1898.

REVENUE STATEMENT.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current ..	£6,909	4·64d.	£6,914	4·10d.	−·54d.
Meter rents ..	117	·08d.	140	·08d.	...
Supply of lamps, &c.	...	...	...	...	...
Sundry fees, &c. ..	...	...	2	...	...
Gross revenue	£7,026	4·72d.	£7,056	4·18d.	−·54d.

The cost of production has slightly risen under the head of "total costs," owing to each item of rent, management, and establishment charges having increased more rapidly than the output. "Oil, waste," has actually fallen even in the gross figure, while "wages" remaining practically the same in the gross has dropped by over ½d. per unit. It is not easy to see why the reduction of ·09d. in works' costs should be swamped by an increase of ·13d. in the other items, thus giving an increase of ·04d. per unit in the total costs for 1898 over 1897.

COST OF PRODUCTION.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase
Coal	£872	·59d.	£1,100	·65d.	+·06d.
Oil, waste, water, and engine room stores.	499	·34d.	482	·29d.	−·05d.
Salaries and wages incurred in generation and distribution.	1,696	1·14d.	1,706	1·01d.	−·13d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	511	34d.	621	·37d.	+·03d.
Works' costs	£3,578	2·41d.	£3,909	2·32d.	−·09d.
Rent, rates and taxes ..	80	·05d.	217	·13d.	+·08d.
Management and expenses, salaries of managing engineer, secretary, clerks, &c.	594	·40d.	701	·41d.	+·01d.
General establishment charges, stationery and printing, law charges and insurance	198	·13d.	247	·15d.	+·02d.
Other expenses	...	...	38	·02d.	+·02d.
Total costs ...	£4,450	2·99d.	£5,112	3·03d.	+·04d.

The profit statement shows that the rates are called upon to bear a little more than the extra interest charges. The rest of the deficit is left over to be met next year (1899).

PROFIT STATEMENT.

	1897.	1898.
Interest on loans	£1,667	£2,166
Sinking fund for repayments	848	845
Net profit carried forward	61	−417
„ charged to rates	...	−650
Gross profit	£2,576	£1,944

Brighton Corporation Electricity Accounts.

THE accounts of the electricity undertaking of the Brighton Corporation show a change which is becoming more and more common in the case of the older undertakings; a lessened net profit, due to the tendency to reduce the prices charged from time to time on the one one hand and the upward movement in cost of fuel and rates of wages on the other. In addition to these influences there is the liability towards special or exceptional outlays for heavy repairs. Thus during 1899 at Brighton there were several items of what may be termed "extraordinary expenditure," which had to be met by the revenue account; such were alterations to buildings, £200; renewal of worn-out accumulators, £470; increased contribution in respect of collecting consumers' accounts, £250. These, together with the increased cost of labour, have raised the total cost per unit sold 0·10d. above that of 1898.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£237,987	£290,930	£52,943
Number of units sold	2,648,701	3,206,623	557,922
Number of lamps connected ...	...	...	...
Gross revenue	£42,136	£45,809	£3,673
Gross profit	£19,289	£16,794	−£2,495
Average price per unit sold ...	3·32d.	2·95d.	— ·37d.

It is interesting to compare the prices at which the units have been sold, as the logical conclusion of the "Brighton scale" has only been reached in Brighton. The figures are:—

	PRIVATE LIGHTING.				PUBLIC LIGHTING.			
Price per unit	7d.	1½d.	1d.	Total.	7d.	1½d.	1d.	Total.
1898 ..	820,985	1,277,811	..	2,098,796	56,475	493,480	..	549,905
1899 ..	976,339	2,769	1,624,931	2,604,039	61,152	..	541,432	602,584

	Units generated.	Units sold.	Public lamps.
1898 ...	3,242,017	2,648,701	257 arc lamps and 941 incandescents.
1899 ...	3,815,743	3,206,623	257 arc lamps and 1,027 incandescents.

The result of the reduction in price has been to cause a drop of over ½d. in the revenue per unit. The receipts from "Supply of lamps, &c., and attendance upon street lamps," amounted to £5,262 in 1899, and against this must be set a portion of wages, &c., in the costs and the whole of the last item put down as "Other expenses (wiring &c)."

REVENUE STATEMENT.

	1898.		1899.		
	Gross.	Per unit.	Gross.	Per unit.	Increase.
Sale of current ..	£36,663	3·32d.	£39,361	2·95d.	−·37d.
Meter rents	948	·09d.	1,122	09d.	...
Supply, of lamps &c., and attendance street lamps	4,504	·41d.	5,262	·39d.	−·02d.
Sundry	21	...	64	...	...
Gross revenue	£42,136	3·82d.	£45,809	3·43d.	− 39d.

We have already referred to the cause of the increase of $\frac{1}{10}$d. in the "Costs." Coal, it will be noticed, has fallen, notwithstanding higher market rates, but, as in the case of many other stations, management and establishment charges tend upwards.

COST OF PRODUCTION.

	1898.		1899.		
	Gross.	Per unit.	Gross.	Per unit.	Increase.
Coal	£7,104	·64d.	£8,331	·62d.	− 02d.
Oil, waste, water, and engine room stores	952	·09d.	1,213	·09d.	...
Salaries and wages incurred in generation and distribution	7,853	·71d.	9,668	·73d.	+·02d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,501	·23d.	4,549	·34d.	+ 11d.
Works' costs	£18,410	1·67d.	£23,761	1·78d.	+·11d.
Rent, rates and taxes	1,209	·11d.	1,091	·08d.	− 03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c,	1,932	·18d.	2,619	·20d.	+ 02d.
General establishment charges, stationery and printing, law charges and insurance	795	07d.	1,100	·08d.	+ 01d.
Other expenses (wiring, &c.)	501	·04d.	441	·03d.	−·01d.
Total costs	£22,847	2·07d.	£29,015	2·17d.	+ 10d.

The satisfactory character of the accounts can be shown by the fact that, although in the two years above dealt with the interest and sinking fund charges have increased by £2,847, the gross revenue has increased by £3,673, or by £826 faster than these charges. Thus, although the "costs" have risen by £6,168, the satisfactory balance of over £1,500 appears as net profit.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£5,844	£7,146
Sinking fund for repayments	6,554	8,099
Net profit carried to reserve fund and credit of rates	2,864	1,549
Net profit carried forward	4,027	...
Gross profit	£19,289	£16,794

CITY NOTES.

Calcutta Electric Supply Corporation.

THE annual general meeting of this company was held on Friday last at Cannon Street Hotel, Col. A. J. Filgate, R.E., presiding.

In moving the adoption of the report (which has already appeared in the ELECTRICAL REVIEW), the CHAIRMAN said that at the last meeting they were able to announce that they had commenced the supply of electricity in Calcutta in the previous month. Their progress at first was slow, owing to the difficulties they had experienced in establishing a new industry in India. They could not get their mains laid so fast as they had intended owing to the difficulty experienced in England, and they were not able to adhere to their original plans; they had to alter them by changing the routes, and by placing mains underground which were originally intended to be placed overhead. Anyone who had had anything to do with the supply of manufacturing materials during the last year would understand how difficult it was to get work done in this country within reasonable time. They suffered more than once for the want of special materials, and their troubles were much enhanced by the fact that such materials had to be sent from England. Under such circumstances the progress they had made in supplying electricity in 8½ months was satisfactory and promised well for the future. At the end of December the lamps and motors connected to the system were equivalent to 9,493 8-C P. lamps for 115 houses. The company's progress since that date had been satisfactory, as on April 13th the lamps and motors had increased to 13,412 lamps, and the houses connected to 193. The report told them that from the date of starting the works to December 31st was 54,897 units. From January 1st to April 13th—3½ months—the sales had reached 74,673 units. In the last letter from Calcutta the day load is stated to be increasing owing to electric fans being connected on to the mains. The outside staff was fully engaged connecting houses, the only difficulty being to get the houses wired quickly enough. The matter of lighting the town by electricity is still under consideration. The company had offered good terms, and hoped that they would lead to business. A great demand for fans had sprung up, and they had sent out a considerable number on their own account, the majority being out on hire. They had a large number on order, but the congested state of the market delayed deliveries. They were doing all they could to increase the supply. They had no desire to become fan suppliers, and would prefer to leave that business to the trade, and confine themselves to the sale of electricity, but while the trade was unable to meet the demand they must continue to ship fans as fast as they could be obtained. The large difference between the sales in the winter and summer experienced in English metropolitan and provincial undertakings would not be met with in India. The sale of electricity in the summer months would equal, if not exceed, that of the winter months. The chairman then referred to the accounts, which were decidedly satisfactory, and spoke well for their future prospects. The balance of profit they were carrying forward. The next accounts would be submitted in the usual Board of Trade form. The greater number of their consumers were located in the European portion of the city. The generating station had been practically finished for some time, and the boilers had been erected. Two steam dynamos of 180 H P. and two of 60 H.P. had also been set up. One of 360 H P. had been landed in Calcutta, and another, with a spare armature, was now in England, and would be shipped shortly. An extra set was being manufactured. They had added considerably to the area of their operations, and that, coupled to the growing demand for electricity, made it clear that before long they would have to enlarge the present station or build one in another locality as might be considered most convenient. They had despatched an engineer to look into the subject and report to the board. Their original contract with Crompton & Co. was £65,000; they had spent £4,590 on site, and ordered additional mains, plant,

and works to the value of £35,000. The company's total commitment, including fans and motors, was about £108,000. As they contemplated further additional expenditure to deal with the enlarged area and to meet the demand, they were asking for the capital to be increased from £100,000 to £200,000 by the issue of 20,000 £5 shares. They would not issue that all at once, but from time to time under such circumstances as might appear desirable. The Government of Bengal had granted an extension of their license to 42 years. The company had commenced negotiations in some quarters with a view to extending the scope of its operations, and had deputed the engineer, already mentioned, to look into these matters on the spot. If there were various places outside Calcutta which would allow the company to embark on schemes, they would be brought before the shareholders in due course before taking actual steps.

The adoption of the report was seconded by Sir G. L. Molesworth, K.C.I.E, and carried unanimously.

Other resolutions authorised the increase of capital, the re-election of Mr. Boulnois, M.P., as a director, the re-election of auditors, and a vote of thanks to the staff at Calcutta.

Isle of Man Tramways and Electric Power Company.

The annual report of the directors, with statement of accounts audited and reported upon by Messrs. W. Aldred, Son & Co., Manchester, has been issued. The directors announce that Messrs. Turquand, Youngs & Co. are preparing a statement of the company's affairs. The directors recommend a reduction of the directors' qualification from £1,000 to £500 stock. Mr. J. A. Mylres, late director of Dumbell's Bank, and Mr. F. G. Callow retire from the board by rotation, and Mr. Alexander Bruce, late manager of Dumbell's Bank, and Mr. J. D. Rogers, late auditor of Dumbell's Bank, also retire. Messrs. Aldred offer themselves for re-election as auditors. Messrs. Aldred deal very fully with the position of the company. They urge the necessity of increased capital, and point out that, whereas there has been a capital expenditure on the general undertaking and the Laxey and Ramsey section of £518,000, only £366,000 has been raised in debentures and share capital, leaving a liability of £150,000 in respect of accounts owing, bills payable, and bank overdrafts. The general undertaking, capital, and liabilities amount to £436,588 16s. 2d., including balance of profit and loss. The property and assets are valued at a like sum, including cash at banks and in hand £1,037. The revenue account shows an income for the year of £46,163. The expenditure, including bank interest £2,365, amounts to £32,905, leaving a balance of £3,258, which, added to the amount from last year, makes £13,364. The debenture interest absorbs £6,500, leaving £6,864 balance of profit and loss account, out of which £5,662 10s. was paid as interim dividend in October last. The liabilities of the Laxey-Ramsey section are £140,122. The revenue account shows a balance to credit of £2,415, which, with the amount brought forward from last year, totals £2,486, which is insufficient to meet the debenture interest of £2,600.

Hooper's Telegraph and India-Rubber Works, Limited.

The directors' report for the year ending March 31st, 1900, to be presented at the shareholders' meeting on May 29th, shows that after payment of the dividends for the year ending March 31st, 1899, the balance remaining to the credit of profit and loss account is £1,523 5s. 7d. Adding to this amount the balance of the trading account for the 12 months ending March 31st last, after placing £500 to the depreciation account, under Article 31, and adding interest on investments, the credit balance is £2,648 13s. 8d. Interim dividends for six months have been paid last October, amounting to £675, and, after carrying an amount of £75 to income-tax and investment account reserve, it is proposed to pay further dividends amounting to £700 to the shareholders on the register on March 31st, 1900, making 5 per cent. on the preference shares, and 10 per cent. on the ordinary shares for the whole year, leaving a balance of £1,198 13s. 8d. to be carried forward.

New General Traction Company.

The fourth annual general meeting of the shareholders of this company was held on Wednesday at the Cannon Street Hotel, under the presidency of Captain Francis Pavy.

The Chairman, in proposing the adoption of the report, said that four years ago the company was a very small concern, certainly as regarded capital, for it only had £50,000 of preference capital, and the item that appeared in the accounts for goodwill. He was approached at the time because the quantity of work in hand required further capital, and believing it to be an extremely good business, he and some of his friends joined it, and as they saw during the period that they had been connected with it, they had been enabled to put in an additional £200,000, and more would be required before they finished their works that they had in hand, and reaped the benefit of what they had been doing. He had no reason to feel disappointed in the outcome. He thought they might be said to have done very well during that period, and he hoped they might be able to do well in the future. It would be a very easy matter to go into the question of electrical traction, and to show how backward we in this country were in comparison with other countries, but that would be wasting their time, for it was patent to everyone that Great Britain was very much behind hand in adopting electricity, not only for traction purposes, but for every other purpose almost. The result of all their work was shown in the report and balance-sheet, which he thought every shareholder should be satisfied with. They would see that after deducting £6,116, the amount of the general expenses, salaries, &c., they were left for the year with £76,299. To that they must add £6,212, brought forward from last year, and the total amount at their disposal was £82,512. During the year they had raised £100,000 additional preference capital which brought that capital up to £250,000. That was raised at a cost of £281, which, he thought, spoke for itself as being a very small sum to spend in raising that amount of money. They had written off that sum, which left them £82,230 to deal with. £13,487 had been paid as the preference dividend, and they had decided to put £10,769 against goodwill. That was always a disagreeable item in any balance-sheet, and personally he would be very glad to see it wiped out altogether. When the company took over the business of the old company, there was an item of £2,230 standing against profit and loss in the balance-sheet, and therefore they had added that to the £10,000 put aside for goodwill. They had charged the year's revenue with £942, the difference in the price of Consols that they were obliged to lodge as caution money in connection with one of their Acts. They had commenced a reserve fund, to which they had placed £20,000, and that left them with £37,030 to start the new year's account with. The figures in the balance-sheet were all based upon taking the tramway shares in which they were interested at par. They had £100,000 in the Coventry Electric Tramway Company, £165,000 in the Norwich Electric Tramway, £21,000 in the Douglas Southern Electric Tramways, £1,973 in a light railway syndicate, and £76,000 in the Philadelphia, Morton, and Swathmore Street Railway. The Coventry Tramways were passed by the Board of Trade, and opened last January, and, therefore, it was too early to state with any accuracy what would be the result of the working of it, but he could tell them that it was going on fairly well. As regarded Norwich, they were coming to a close in that matter. The line was completed, and he hoped that within the next three weeks or a month they would be asking the Board of Trade to go down and pass the works, and that in about six weeks they would be running. Douglas was a pleasure tramway, and open during the summer months, and that paid very well. It had been working for two years, and last year it did very well indeed. The light railway syndicate was some concessions which they had for light railways, which they hoped in the long run would turn out to their advantage. The Philadelphia, Morton and Swathmore street railway was a line in the neighbourhood of Philadelphia, and two of their directors had had an opportunity of seeing what it was like. Mr. Hopkins, their managing director, had only just returned from the States, and he was of opinion, in which he (the chairman) joined, that that railway was one of their most valuable assets. As to the future, they had had a good deal of business submitted to them, and some of it had given them a good deal of anxiety, and the more experience he had in dealing with public bodies in England the more he realised the difficulties of coming to a satisfactory arrangement with them. People got it into their heads that the best thing for a town was to run its own tramways, but he thought there would always be plenty of work for such a company as theirs.

Baron Emile B. D'Erlanger seconded the resolution, and after some discussion the report was adopted.

A resolution was also carried making the remuneration of the chairman £400 a year, and of the directors £200 per annum each, such remuneration to date from the incorporation of the company.

Mix & Genest, Limited, of Berlin.

We are informed that the eleventh general meeting of shareholders of this company was held last Saturday, when the directors submitted a most satisfactory report. The balance-sheet shows a gross profit of £30,090, which, after making provision for depreciation on plant, tools, and buildings, to the extent of about £11,800, leaves a net profit of £18,290. The shareholders receive a dividend of 12 per cent., £1,000 go to a reserve, which now stands at £36,000, directors' fees and gratifications to managers and engineers absorb £4,300, and £800 are given to their workmen's sick fund, while £432 are carried forward to the new account.

In their report the directors are able to state a progressive development, mainly due to the large extension of the telephone system in Germany, which brought also during the last year to them important orders for multiple switchboards, telephone instruments, &c., and which requirements of the German Government, they prognosticate to be still larger in the future on account of the adoption of the metallic circuit system. A further impetus has been given to the telephone industry by the German General Post Office allowing subscribers' private installations to be connected to the Government telephone system, free of charge, the only stipulation being that the instruments used on such private installations should be equal in quality to those used by the Government, and as the greater portion of the Government instruments are made and supplied by Mix & Genest, the sales to the trade have considerably increased. All departments are not only fully occupied for a long time, but the volume of business to be dealt with necessitated a further extension of the factory which now employs 1,500 hands.

Prospectus.

The list closes to-day in the issue, at the price of £103 per cent., of £100,000 in 4 per cent. debenture stock, guaranteed by the Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company. The money is required for the construction and equipment of a new generating station for the supply of power jointly to both companies.

Works' costs ... ...£18,410 1·67d. £23,761 1·78d. +11d.

they had spent £4,590 on site, and ordered additional mains, plant,

Power is taken to issue a further £100,000 as and when required, to rank *pari passu* with the present issue, the stock being secured by a first mortgage on the freehold joint station in addition to the guarantee of the two companies.

Stock Exchange Notices.—Applications have been made to appoint a special settling day in Nernst Electric Light, Limited—25,000 vendors' 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 115,001 to 140,000, and to allow the following to be quoted in the Official List:—British Insulated Wire Company, Limited—Farther issue of 12,500 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 27,501 to 40,000.

Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to Alliance Electrical Company, Limited, 7,000 5 per cent. cumulative preference shares of £10 each, fully paid, and Dorman, Long & Co., Limited, provisional certificates for £400,000 4 per cent. first mortgage perpetual debenture stock; and to allow the following security to be officially quoted:—New General Traction Company, Limited, further issue of 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 54,001 to 74,000.

West India and Panama Telegraph Company, Limited.—The profit for the half-year ended December 31st, 1899, being insufficient to provide the preference dividends, the directors have decided to withdraw the sum required from the reserve fund and recommend on this occasion the payment of the usual dividends on the cumulative preference shares and 1s. per share on the ordinary shares.

Dorman, Long & Co., Limited.—The directors have decided that an interim dividend of 5 per cent. shall be paid on June 8th to shareholders registered on the company's books on the 23rd inst.

Compagnie Générale de Traction, of Paris.—The increase of capital to 30,000,000 francs by the issue of 100,000 new shares of 100 francs each was sanctioned at an extraordinary meeting held on the 2nd inst. The right to subscribe 66,667 of these shares has been reserved for present shareholders, which is at the rate of one new share for three old shares, at a price of 230 francs per share. The payment of the 130 francs premium, and the first call of 25 francs per share, equal to 155 francs per share, is due and payable at the bankers of the company, Messrs. Henrotte Fils and Cie, 20, Rue Chauchat, Paris, on or before 25th inst.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending May 12th, 1900, were £331 18s. 10d.; receipts for corresponding period, 1899, £362 10s. 9d.; aggregate for half-year to date, £4,584 6s. 4d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 11th, 1900, were £2,849 17s. 2d.; corresponding period, 1899, £2,863 2s. 8d.; decrease, £13 5s. 1d.

The City and South London Railway Company.—The receipts for the week ending May 18th, 1900, were £1,380; ditto May 14th, 1899, £926; increase, £454. Total receipts for half-year, 1900, to date, £23,625; corresponding period, 1899, £20,243; increase £3,382. Miles open May 13th, 1900, 3½; May 14th, 1899, 3½.

The Dover Corporation Tramways.—The receipts for the week ending May 12th, 1900, were £177 19s. 6d.; May 13th, 1899, £154 10s. 6d.; increase, £23 9s. 0d. Total receipts to date, 1900, £3 020 18s. 9½d.; corresponding period, 1899, £2,885 19s. 11d.; increase, £134 18s. 10½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,934; 1899, 4,062. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, May 11th, 1900, were as follows:—D. U. T. Co., horse cars £55 3s. 7d.; ditto, electric cars, £3,452 9s. 7d.; D. S. D. Co., electric cars, £822 11s. 5d.; total, £4,330 4s. 7d.; corresponding week last year—D. U. T. Co., horse cars, £1,857 6s. 1d.; ditto, electric cars, £1,180 13s. 7d.; D. S. D. Co., electric cars, £819 3s. 11d.; total, £3,907 3s. 7d.; increase, £523 1s. 0d. Aggregate to date, £76,217 7s. 6d.; aggregate to date last year, £63,549 5s. 10d.; increase to date, £12,668 1s. 8d. The mileage worked is 49 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending May 13th, 1900, were £634; week ending May 14th, 1899, £431; increase, £203. Total receipts to date, 1900, £3,931; ditto, 1899, £2,657; increase, £1,274. Number of cars, 1900, 28; 1899, 15. Miles of track open, 1900, 12; 1899, 6¼

The Liverpool Overhead Railway Company.—The receipts for the week ending May 13th, 1900, amounted to £1,416; corresponding week last year, £1,339; increase, £77. Total traffics from January 1st to date, £26,752; corresponding period 1899, £25,628; increase, £1,124. Miles open, 6 57 chains.

The South Staffordshire Tramways Company.—The receipts for the week ending May 11th, 1900, were £680 4s. 8d.; May 12th, 1899, £635 4s. 10d. Aggregate receipts for 19 weeks, £12,278 1s.; last year, £11,720 10s.

STOCKS AND SHARES.

Wednesday Evening.

After their flatness of last week the Stock Exchange markets have shown a reviving tendency, the easier conditions of Lombard Street, and the better news from the front, combining to put a little more brightness into the speculative departments, and through them into the investment sections of the House. Various reports as to trouble which was likely to occur in the ranks of members of the Stock Exchange have acted as a barrier to anything like animation in the investment markets, and the end of a nineteen-day is usually a very nerveless affair. But the outlook for the moment is considerably brighter, and with a continuance of satisfactory intelligence from the seat of war, we may fairly expect prices to gradually improve.

There are now to be found many second-class securities in the electrical and kindred markets which have been unduly depressed in consequence of the stringency of the Money Market, and which would doubtless be standing at higher values were not loanable capital so expensive. As an instance, we may mention Callender's Cable Preference, upon which a good rate of interest can be obtained, with the advantage of a free market being always maintained in the shares. Of another, and a more speculative description, we may mention National Telephone third Preference, which can now be bought to yield just a trifle under 5 per cent. In the event of the company being bought out or taken over by the Government, it is probable that the Preference shareholders at least would be paid out in full.

The activity of the Post Office in laying its telephone wires has brought about a weakening generally of National Telephone securities. Despite the near approach of Government competition, the company's service is no better than before, and if it will not amend its ways in this respect, we hardly see how it can expect to retain its subscribers when a newer and better system is inaugurated. For their own sakes, National Telephone shareholders should impress upon their directors the crying need for reform which now exists.

Electricity Supply shares show little quotable change on the week, but there are several interesting features in the market whose developments may have considerable influence over its future course. The Stock Exchange, and many of the shareholders, have now got their own way as regards the issue of the new Westminster Electrics at par, *i.e.*, £5. A confirmatory meeting is to be held on 23rd inst., but it is practically certain that the £5 proposal will be adhered to. This means, of course, a very pleasant little bonus to shareholders. London Electrics continue weak; there seems no strength left in the shares. Charing Cross and Strand are hard, and the Preference have improved 5s. We should not be much surprised if the Board of Trade insists upon a separate undertaking being formed to deal with the company's powers to enter the City. As a matter of fact, the Charing Cross and Strand is already working its way into its rival's domains, and, although a solemn kind of secrecy is preserved by some people on the subject, we have good authority for stating that the company has already got very close to Ludgate Circus. City of London Ordinary remain at 10½. The company's recent success in the law courts may prove only transitory when the case is taken to a higher tribunal, and we suppose that a long period of litigation lies before the unfortunate City concern.

The Kensington and Knightsbridge and the Notting Hill Electric are making a new issue of £100,000 4 per cent. Debenture stock at 103. Offered primarily to shareholders in the two companies, it will no doubt be principally taken by them. As an investment it is a good security, and we hope that some market will be made in the stock, as such a proceeding, by rendering the security easily negotiable, would enhance its value. It is redeemable at par in 1931.

The telegraph department is inactive. Anglo-American descriptions continue weak, but the Deferred stock has now reached a limit at which it looks fairly cheap as a speculation. The 4 per cent. Debenture stocks of both the Eastern companies have fallen a couple of points, as though to point the moral of what we were saying last week with regard to the comparative dearness of such investments. Telegraph Construction have dropped, and Electric Construction are ½ easier.

The British Electric Traction report is expected daily, and the dividend estimates range from 8 to 10 per cent. on the Ordinary shares. We would remind our readers that the alteration of the company's financial year will make the report and accounts extend over 15 months—an important point to bear in mind when instituting a comparison. A comprehensive system of electrical railways in Cheshire is being talked about, the moving spirits being the Light Railway Syndicate, with which Mr. Scotter's name is identified.

Metropolitan District Stock is now 30, and a flutter of anticipation is making itself felt as the time draws to hand for the first practical experiments with that electric traction which is to bring, according to the company's supporters, salvation to the District line. City and South London stock has paused in its downward career and shows symptoms of improvement. Central Londons are quiet and featureless, and there is no change to report in Waterloo and City stock.

The announcement made on this Wednesday afternoon that the Eastern Extension Company's directors intend to issue the remaining 50,000 shares to holders of the existing issue was favourably received by the market. By offering the new shares at £13, a bonus of 6s. or 7s. falls to the proprietors, and the latest creation will probably start in the market with a quotation of about 35s. premium per share.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, May 9th.	Closing Quotation, May 16th.	Business done during week ended May 16th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	62 — 65	62 — 65	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	114 —115	114 —115	114⅜	114
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	13⅜— 14¼	13½— 14	13¹⁵/₁₆	13¹⁵/₁₆
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	...	2¼— 2½	2¼— 2½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	...	...
16,000	Cuba Telegraph	10	7 %	8 %	...	9 — 10	8½— 9½xd	9¹¹/₁₆	9¼
6,000	Do. 10 % Pref.	10	10 %	10 %	...	19 — 20	18½— 19½xd	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	101—105%	101 —105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11½— 12	11½— 12	11⅞	11¹³/₁₆
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	150 —155	150 —155	153	150
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	98 —101	101	98½
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	113 —118	111 —116	112	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15⅝— 16¼	15⅝— 16¼	16⅛	15¹³/₁₆
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118 xd	111 —116	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	11¼— 11⅜	11¼— 11⅜	11⅞	11⅞
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	15½	15⅛
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	12½%	...	32 — 34	32 — 34	...	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	54 — 58	52 — 56 xd	55¼	53
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4½— 5½	4½— 5½	5	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	11 — 13	12	11
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5½— 5⅝	5 — 5½	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 —100	96 — 99	98½	97½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	1 1/16— 1 1/16	1 1/16— 1 1/16	1	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	102 —105	102 —105	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	126	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4⅜— 5¼	4⅜— 5¼	...	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	..	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	97 —100	97 —100	99¼	9⁹/₁₆
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	..	...	100 —104	102 —105	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14½— 15	14½— 15	14⅞	14⅛
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	..	...	105 —108	105 —108	...	...
88,821	West India and Panama Telegraph	10	⅝%	2 %	...	¾— 1½	¾— 1½	1 1/16	...
34,568	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	9½— 9⅝	9½— 9⅝	9½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	7 — 8	7 — 8	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...	...	8¼— 9½	8½— 9¼	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	8½— 9½	8½— 9¼	...	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	5½— 5⅝	5¼— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	6½— 7½	6½— 7½	7⅜	7
150,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	...	...	108 —111	108 —111	110½	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	10 %	6 %	4 %	10— 11	10 — 11	10¼	10¼
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	12⅝	12⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	4 %	9½— 10½	9½— 10½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	...	...
200,000	Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	109 —112	109 — 112	111	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock ...	100	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	8	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. 6 % Pref.	5	...	6 %	...	4¼— 4⅜	4 — 4½	4	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13½— 14½	13½— 14½	14⅛	13⅞
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	114 —117	...	...
220,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	97½	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15¼	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9⅛	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2¼	2 — 2½	2	...
50,000	Do. Do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	4 — 4½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	12 %	12 %	13 %	14½— 15½	14⅛— 15½	15⅝	...

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation May 9th	Closing Quotation May 16th.	Business done week ended May 16th, 1900. Highest.	Lowest.
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅜— 3¼	2⅜— 3¼	3	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	15½— 16½	15½— 16½	...	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12½	...
200,000	Do. do. 5 % Perpetual Debenture Stock	Stock	...	...	...	124 —127	124 —127	...	...
45,000£	†British Electric Works Co., Ord. £1 shares, 50,001—95,000	...	...	...	...	⅞— 1	⅞— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000	...	...	...	...	1 1/16— 1 5/16	1 1/16— 1 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500	5	...	...	...	6 — 6½	6 — 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	...	1¾— 2	1¾— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2	...
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	108 —113	108 —113	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000	5	12½%	15 %	...	14½— 15½	14½— 15½	15¼	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¾— 6	5¾— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —116	112 —116	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10⅛
61,033	Do. do. Pref. half-shares	5	...	...	...	4¾— 5¼	4¾— 5¼	5¼	5 1/16
71,447	Do. do. Def. do.	5	...	...	...	5 — 5⅛	5 — 5⅛	5⅛	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	61 — 64	61 — 64	...	...
37,500	Do. do. Ord. shares, Nos. 22,501 to 60,000	10	...	...	...	5¾— 6½xd	5¾— 6¾	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	...	3¾— 4	3¾— 4	3 1/16	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	99 —102	100 103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	...	3¾— 4¼	3¾— 4¼	4¼	...
344,023	Do. do. do. 4 % Deb. Stock Red.	100	...	...	...	93 — 95	93 — 95	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2⅛— 2⅜	2 — 2¼	2¼	2 1/16
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 %	7 %	...	2¾— 3¼	2¾— 3¼	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock	Stock	...	...	...	103 —106	103 —106	...	...
9,600£	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13½— 14½	13½— 14½	14⅛	13⅜
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5¼— 5⅜	5¼— 5⅜	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works	10	10 %	10 %	...	21 — 22	21 — 22	21 9/16	21 3/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3¾%	8 13/16— 8 15/16	8⅞— 9	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13½— 13¾	13½— 13¾	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	34 — 38	36	35
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	...	10 — 11	10 — 11	...	...
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	100 —103	100 —103	100	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid. ⅜—½ xd.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10½—10¾.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅛—8⅛. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 18.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (January 25th, 1900).

MARKET QUOTATIONS, Wednesday, May 16th.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£34	£34	..
a " " .. .. per ton	£31	£31	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26	£26 10	10s. dec.
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a " White Sugar .. .. .. per ton	£31	£31	..
a " Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks .. per lb.	4¼d.	4¼d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a " Recovered .. .. per ton	£5 10	£5 10	..
a " Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a " Crystals .. .. .. per ton	£8	£8	..
a " Bichromate, casks .. per lb.	3½d.	3½d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b " Sheet, in ton lots .. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£80 to £150	£80 to £150	..
c Brass (rolled metal 9" to 12") basis per lb.	8¼d.	8¼d.	..
c " Tube (brazed) .. .. per lb.	10¼d.	10¼d.	..
c " " (solid drawn) .. per lb.	9d.	9d.	..
c " Wire, basis .. .. per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed) .. .. per lb.	11¼d.	11¼d.	..
c " " (solid drawn) .. per lb.	11¼d.	11¼d.	..
g Copper Bars (best selected) .. per ton	£87	£88	£1 dec.

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£87	£88	£1 dec.
g " Rod .. .. .. per ton	£87	£88	£1 dec.
c " (Electrolytic), Bars .. per ton	£92	£95	£3 dec.
c " " Sheets .. per ton	£92	£94	£2 dec.
c " " Rod .. per ton	£85	£88	£3 dec.
c " " H. C. wire per lb.	9¼d.	10d.	¼d. dec.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	8/- to 8/6	8/- to 8/6	..
h India-rubber, Para fine .. per lb.	4/2 to 4/2½	4/3	dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	74/1½	74/9	7½d. dec.
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	70/- to 72/6	70/- to 72/6	..
i " Wire galvanised No. 8 .. per ton	£13 10	£14 5	15/- dec.
g Lead, English Ingot .. .. per ton	£17 2 6	£17 2 6 to £17 5	..
g " " Sheet .. .. per ton	£18 10	£18 10	..
m Manganin Wire No. 28 .. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£9 10	£9 10	..
d Mica (in original cases), small per lb.	3d. to 9d.	3d. to 9d.	..
d " " " medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet per lb.	From 1/3	From 1/3	..
o Platinum .. .. per oz.	£8 12	£8 12	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1 1	10½d to 1/-	..
i Steel, Magnet, acc'd'g to deso'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£138 to £139	£140 10s. to £141 10s.	£2 10s. dec.
g " foil .. .. per lb.	1/9	1/9	..
n " wire Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	8¼d.	8¼d.	..
j " Best Flax, 6 lea. .. per lb.	6d.	6d.	..
j " Hemp, 3 ply 10 lbs. .. per lb.	4½d.	4½d.	..
j " " Russian, 10 lbs. .. per lb.	5½d.	5½d.	..
j " Jute, 180 lbs. rove .. per ton	£14	£14 10	10/- dec.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£27 5 nett.	£27 5 nett.	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

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f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
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p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON DISTANT ELECTRIC POWER TRANSMISSION.

By Prof. George Forbes, F.R.S., Member.

(*Paper read April 26th*, 1900.)

(*Continued from page* 802.)

The Carborundum Company's plant is chiefly interesting for the adjustable transformers, which allow very large variations in the volts and current. These have often been described in technical journals. This service could not have been given had we adopted three-phase alternators, and the rotary transformers would not have succeeded but for our low frequency.

In the new works of the Carbide Company, 10 Wagner transformers, each of 2,000 H.P., were being put in when I was last there. This plant is interesting from the fact that the serious short circuits frequently occurring in the electric furnace can be satisfactorily dealt with.

Passing over other matters concerning which a volume might be written, it will be well to say a few words about the transmission line to Buffalo.

The chief peculiarity of the Buffalo transmission line is that three-phase currents are used, though generated in two phases. I very much preferred alternators of two phases as being more easily tested and attended to, and as giving a more useful machine. For the transmission to Buffalo I had no great preference for one over the other, but I found that we should be better served by yielding to the wishes of the contractors and putting in Mr. Scott's ingenious arrangement for changing from two-phase to three-phase. Fig. 1 shows the connections.

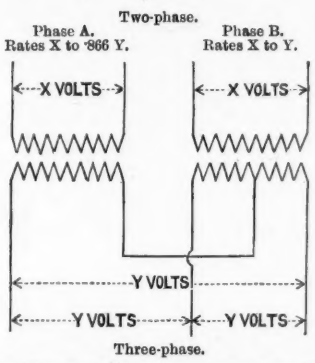

Fig. 1.—Sketch Showing Transformation from Two Phases to Three Phases.

There were six bare cables on one cross-arm of the posts all the way from Niagara to Buffalo, but this arrangement is to be altered.

From Niagara to Terminal House, Buffalo, is 25 miles.
" Terminal House to Railway House is 2 "
" " " lighting " 4 "
" " " 3 sub-stations 4½ "

The full-load inductive E.M.F. is 15 per cent. of the whole. At some stations the current leads the E.M.F. instead of lagging. The Buffalo cables are three insulated lead-covered cables in a pipe, and the capacity of each is 0·55 mf. per mile from copper to lead. The conductors on the transmission line are 0·6 inch diameter, 18 inches apart half the way, 36 inches the rest. The posts are 75 feet apart. The top cross-arms are 30 feet above ground. The posts are 8 inches diameter at the top. They are not strong enough for the weight and are bent badly.

Originally a barbed wire ran the whole distance over the conducting wires. After the snowstorm of December 4th, 1898, it was removed. It was grounded at every second post.

Having looked carefully into the cause of every interruption of electric supply that has occurred in four years, I have to say that not a single electrical trouble has occurred that might not be prevented in any similar plant laid down in future.

In this brief reference to the work at Niagara Falls many features of considerable importance must be omitted; but I should like to draw attention to the ingenious automatic cut-outs with the introduction of which I had nothing to do, and which I am therefore free to praise, as they have been of the highest value in preventing interruptions of supply on the Buffalo transmission. The electro-magnetic arrangement, which comes into play when excessive current passes due to a short circuit, merely serves to start some clock mechanism which after a short period cuts out the line if the excessive current is still passing. On the Buffalo distribution these automatic cut-outs are set so as to act after 1 or 2 seconds; at the Buffalo end of the transmission line after 3 seconds, and at the Niagara end after 4 seconds. Thus a short in Buffalo cuts out the distributing lines, and no others. At the Terminal House, Buffalo, it cuts out the supply mains, but not the transmission line; and at Niagara if a short lasts 4 seconds the supply to the transmission line is cut out.

Another ingenious appliance at Buffalo is a motor supplied by the three transmission cables so balanced that the motor will not move except when the balance is destroyed by an earth or short circuit on the line, when its motion removes the defective line, or switches the whole load on to the other line.

There is a practical matter regarding the regulation of the turbines which deserves notice. At the period of my last inspection Buffalo was supplied by two dynamos. Now the first three turbines put down were regulated by a purely mechanical governor; the later ones by a more sensitive electrical governor. It is found in practice that the supply at Buffalo is most steady when the two turbines driving the dynamos are regulated, one by a sensitive and the other by a coarser governor.

In conclusion of these remarks about the Niagara-Buffalo transmission it may be interesting to mention a few of the causes of interruption of the current. Some of the Italian workmen stole copper wire. They were put in prison. Whereupon their relatives short circuited the wires. Boys threw chains over the transmission wires to watch the sparks until the detectives caught them. Short circuits or earths have also been caused by fumes and carbon dust deposited on snow on the insulators, by July 4th rockets, by sleet, by lightning, by careless workmen, by rats. Interruptions have occurred by overload on rotary transformers, by attendants using switches wrongly, by lightning arresters, by bad switches on consumers' premises, by accidental fire, by ice blocks on the canal head-race. Insulators are a temptation to the owners of revolvers, but this trouble has not existed at Niagara so much as in Switzerland. These are only extracts from the nearly complete list which I made out from four years' working.

Table I.—100 Miles; 10,000 Volts. One Section.

ϵ = Inefficiency. E = Efficiency.

ϵ.	E.	Tons of copper per KW. delivered.	Tons of copper per H.P. delivered.	ϵ.	E.	Tons of copper per KW. delivered.	Tons of copper per H.P. delivered.
1·00	...	...	...	1·46	·685	·72800	·54309
1·01	·990	16·0258	11·9553	1·47	·680	·72230	·53884
1·02	·980	8·1726	6·0968	1·48	·676	·71689	·53480
1·03	·971	5·5555	4·1444	1·49	·671	·71179	·53100
1·04	·962	4·2480	3·1690	1·50	·667	·70695	·52739
1·05	·952	3·4641	2·5842	1·51	·662	·70236	·52396
1·06	·943	2·9420	2·1947	1·52	·658	·69801	·52072
1·07	·935	2·5695	1·9169	1·53	·654	·69388	·51763
1·08	·926	2·2905	1·7087	1·54	·649	·68997	·51472
1·09	·917	2·0739	1·5471	1·55	·645	·68624	·51194
1·10	·909	1·9009	1·4181	1·56	·641	·68271	·50930
1·11	·901	1·7594	1·3125	1·57	·637	·67936	·50680
1·12	·893	1·6422	1·2251	1·58	·633	·67617	·50442
1·13	·885	1·5430	1·1511	1·59	·629	·67316	·50218
1·14	·877	1·4584	1·0880	1·60	·625	·67030	·50004
1·15	·870	1·3852	1·0334	1·61	·621	·66756	·49800
1·16	·862	1·3212	·9856	1·62	·617	·66499	·49608
1·17	·855	1·2650	·9437	1·63	·614	·66254	·49426
1·18	·847	1·2153	·9066	1·64	·610	·66021	·49252
1·19	·840	1·1709	·8735	1·65	·606	·65801	·49088
1·20	·833	1·1311	·8438	1·66	·602	·65592	·48932
1·21	·826	1·0953	·8171	1·67	·599	·65393	·48783
1·22	·820	1·0628	·7929	1·68	·595	·65206	·48644
1·23	·813	1·0334	·7709	1·69	·592	·65028	·48511
1·24	·806	1·0065	·7509	1·70	·588	·64860	·48386
1·25	·800	·9819	·7325	1·71	·585	·64702	·48268
1·26	·794	·9593	·7156	1·72	·581	·64551	·48155
1·27	·787	·9385	·7001	1·73	·578	·64409	·48049
1·28	·781	·9192	·6875	1·74	·575	·64276	·47950
1·29	·775	·9014	·6724	1·75	·571	·64149	·47855
1·30	·769	·8849	·6601	1·76	·568	·64031	·47767
1·31	·763	·8697	·6488	1·77	·565	·63919	·47684
1·32	·758	·8554	·6381	1·78	·562	·638148	·476059
1·33	·752	·8421	·6282	1·79	·559	·637170	·475329
1·34	·746	·8297	·6190	1·80	·556	·636255	·474646
1·35	·741	·8180	·6102	1·81	·552	·635401	·474009
1·36	·735	·8072	·6022	1·83	·546	·633870	·472867
1·37	·730	·7970	·5945	1·85	·541	·632559	·471889
1·38	·725	·7874	·5874	1·87	·538	·631452	·471063
1·39	·719	·7783	·5806	1·89	·530	·630536	·470380
1·40	·714	·7698	·5743	1·91	·524	·629798	·469829
1·41	·709	·7618	·5683	1·93	·518	·629228	·469404
1·42	·704	·7542	·5626	1·95	·513	·628813	·469094
1·43	·699	·7472	·5574	1·97	·508	·628544	·468894
1·44	·694	·7404	·5523	1·99	·503	·628416	·468798
1·45	·690	·7340	·5475	2·00	·500	·628400	·468786

I now turn to the second portion of this paper dealing with some of the problems which I suppose have been threshed out independently by each one who has had to carry out any large transmission scheme. I wish to draw attention to Lord Kelvin's law of economy, to the use of boosters and phase rectifiers, to the relative merits of different kinds of polyphase systems, to overhead and underground conductors, and to the use of aluminium.

Kelvin's Law.

I should like to see an accurate volume published on the correct use and development of Kelvin's law of economy. Here I must condense. The data on which we choose our current density by this law depends on (1) price of copper, (2) price per annum of the horse-power, (3) interest on price of copper. I desire to draw attention to the meaning of (2) and (3). When using water-power which is unlimited com-

pared with the demand, (2) is the price per annum of generating the power. When the water-power is limited, and the demand unlimited, (2) is the selling price of the power. If the copper be mortgaged, (3) is the interest paid on the mortgage—say 4 per cent. If the copper is paid for out of capital, (3) is the interest to be paid in dividends on the capital—say 15 per cent. I do not think that attention has been explicitly directed before to these points.

Boosters.

Lord Kelvin's law, as he announced it, was only true if the electric power measured at each end of the line was approximately the same; in other words, if the percentage drop in volts was small. Ayrton and Perry showed that Lord Kelvin, through neglect to notice this, was led to deduce wrong conclusions as to the economical current density to transmit power from Niagara to New York.

But by using boosters along the line the drop in volts can be corrected. Take as example an ordinary transmission line of 40 miles, in which the ohmic loss in power and volts is 40 per cent. Divide the line into four sections of 10 miles, with a loss of 10 per cent. in each. Now place alongside of it a booster line. At the 10-mile station increase the volts to the original amount by a booster at the expense of 10 per cent. of current. In the second section there is only 90 per cent. of the current, so if the conductor is the same sectional area throughout, the second section of the booster line may be 11 miles before loosing the same as any section of the non-booster or ordinary line. The third section will have a length of $1{\cdot}1 \times 1{\cdot}1 \times 10$ miles $= 12{\cdot}1$ miles; the fourth has a length of 13·31 miles. Thus, on the booster line, the total loss of 40 per cent. is reached only after traversing a distance of

$$10 + 11 + 12{\cdot}1 + 13{\cdot}31 = 46{\cdot}41,$$

instead of 40 miles without boosters, and with the same sized wire. If, instead of keeping the wire of constant section in the booster line, we had kept the length of sections each of 10 miles, and had kept the current density constant, the sectional area of the conductor in the four sections would have been in the ratios 1·0, 0·9, 0·81, 0·729, whose sum is 3·439. The weight of copper on the booster system would be thus reduced in the ratio 3·439 : 4, while the efficiency would be 65·61 per cent. instead of only 60 per cent. without boosters; or, to put it in another way, the same loss at 40 miles would be obtained on the booster line with a reduction in weight of copper in the ratio of $34{\cdot}4^2 : 40^2$, which requires only 74 per cent. of the copper. In this example the loss in the booster has been neglected for simplicity of description, but would be taken account of in practice. If the efficiency of the alternating current booster is 98 per cent on $\frac{1}{10}$th of the power, the total loss in the booster is $\frac{1}{50} \times \frac{1}{10} = \frac{1}{500}$ of the power, which may well be neglected in a general statement of results. The effects of capacity and self-induction (if alternating currents be used) have also been omitted in this description, and if not nullified the usual corrections must be made.

Table I. gives the weight of copper per horse-power and kilowatt delivered at the receiving end of a transmission line 100 miles long with 10,000 volts at the generating end, without boosters, *i.e.*, in one section. Tables II., III. and IV. give the results with boosters when the line is divided into two, three, and four sections respectively. Corrections must be made for capacity, self-induction, temperature, and sag.

(To be continued.)

Table II.—100 Miles; 10,000 Volts. Two Sections.

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
·017	59·17	2·27
·12	8·27	·504
·32	3·13	·333
·61	1·63	·395
·92	1·09	1·451

Table III.—100 Miles; 10,000 Volts. Three Sections.

Efficiency.	Inefficiency.	Total copper per H.P. delivered.
·07	13·5	·488
·09	11·0	·435
·11	9·2	·393
·13	7·7	·361
·15	6·5	·335
·18	5·5	·315
·21	4·8	·300
·24	4·1	·290
·28	3·6	·283
·32	3·2	·280
·36	2·8	·280
·40	2·5	·285
·45	2·2	·295
·51	2·0	·311
·56	1·8	·336
·62	1·6	·375
·69	1·5	·437
·76	1·3	·545
·84	1·2	·766
·92	1·1	1·441

Table IV.—100 Miles; 10,000 Volts; Four Sections.

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
·10	9·8	·344
·21	4·8	·267
·38	2·7	·260
·63	1·6	·365
·92	1·1	1·435

THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

By H. M. Sayers, Associate Member.

(Paper read May 3rd, 1900.)

(Continued from page 804.)

Using correct data to suit the case, a very good judgment can be arrived at as to the most economical system to be adopted, and it is suggested with much confidence that such calculation is a safer guide than a general statement that for a traction station of over so many thousand H.P. this or that system is the only commercial one. It seems to be overlooked sometimes that the cost per unit at the car, and not at the switchboard, is the commercial criterion, and that to attain a lower figure at the car the cost of the unit at the switchboard must be very considerably lower in the case of any system using moving transformers than in alternative arrangements.

The choice of a site for a generating station may greatly affect the generation costs, and as these materially influence the design of the distributing system, the importance of careful choice of site or sites is very great, and in any contemplated electric traction system this should be one of the earliest matters submitted to and decided by the engineer. Whenever possible, eligible sites for compulsory purchase should be scheduled in the order authorising the line. The points affecting the choice are foreign to the subject now discussed, and a certain cost per unit at the switchboard will be herein assumed, the sole subject considered being the delivery of the power to the cars at minimum cost under the conditions imposed. The economical use of the power on the cars is also foreign to this discussion, but it cannot be seriously contended that waste on the car excuses avoidable waste in the distributing plant. The consideration of a particular case will best illustrate the application of the foregoing principles. Diagram A. is a scale plan of a tramway system, all single lines with

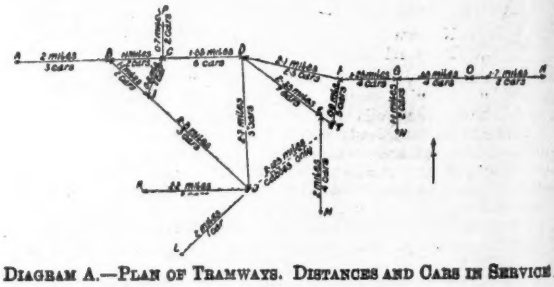

Diagram A.—Plan of Tramways. Distances and Cars in Service.

turnouts. The proposed service results in a distribution of cars as marked in figures along each section of the line. The total number of cars is 57. The average current taken by each car is reckoned at 15 amperes. Hence the average power demanded at the cars will be

$$\frac{57 \times 15 \times 500}{1{,}000} = 427{\cdot}5 \text{ KW.}$$

At T is a site available for a power house. The extremes as regards distance from T are A 7·1 miles west, H 5·2 miles east, and L 7 miles south-west of T. There is, however, a shorter route from T to J than by the tramway, and this route being available for a feeder cable reduces the distance T L to about 4·35 miles and facilitates feeding at J, which it will be seen is an important centre. In natural order one should first consider the use of T as sole generating station for the whole system, find the most economical current density, and see whether the drop permits of low tension generation and direct feeding (Diagram B).

For the purpose of this example the following figures are used:—

Annual charges on cost of cable for interest and depreciation, 7 per cent. or R = 7.

Annual hours of use, say $15 \times 365 = 5{,}475$.

Cost of energy per B.O.T. unit at switchboard s = ·75d.

Tons of copper per mile run of 1 square inch cross-section = m = 9·1.

Cost of insulated cable per ton of copper p = £151.

Watts continuously lost worth £1 per annum = $w = \frac{240}{c \quad D} \times 75$ = 58·45.

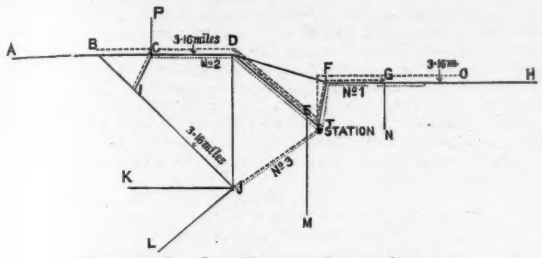

DIAGRAM B.—LOW-TENSION SINGLE STATION

Trolley feeders ——— Track feeders .....
Limit of 50 volts drop = 3·16 miles, trolley side.
Limit of drop in rails, 5 volts = 173 ampere miles.

Then by formula given in Appendix No. 1 we have:—

$$t^2 = \frac{B \cdot w \cdot p \cdot m \cdot \cdot 045}{100} = \frac{7 \times 58{\cdot}45 \times \cdot 045 \times 9{\cdot}1}{100}$$

$$= 251 \text{ or } t = 15{\cdot}8;$$

say—

$\frac{t}{\cdot 045}$ = 352 amperes per square inch is thus the most economical density in this case. The voltage drop per mile is 15·8.

Hence the drop from T to A would be 15·8 × 7·1 = 112 volts, and from T to H 15·8 × 5·2 = 82 volts. These are too great for good working, and taking 50 volts as the limit, the distance limit is $\frac{50}{15{\cdot}8}$ = 3·16 miles. Beyond this limit there are 15 cars west and three cars east of T, so that two-thirds of the load comes inside the permissible drop, and should be supplied by directly-fed cables. The remainder should be fed by "boosted" cables. No allowance is made for the conductivity of the trolley wires excepting where they suffice without cables in parallel, and there two No. 0 wires of ·162 square inches combined section are reckoned on. It is found in practice that in a tramway system calling for several feeders it is better to work the trolley wire in separate sections, each being fed by a distinct feeder. This results in the rapid localisation of short circuits of all kinds and minimises disturbance to traffic. It also facilitates the proper loading of the individual feeders and gives valuable information to the power-house staff as to the distribution of the load.

The losses in the feeders to the directly-fed portions of the sample system will be approximately as follows:—

The cable T J has to carry 98 amperes 2·125 miles; the average length on the branches beyond J over which the power will be distributed is, say, 1 mile total from J 3·125 miles. The branches J D and J I will only be fed *vid* J to points equidistant from T by the other routes, and on all these branches the trolley wires suffice without cable. The remainder of the current from T within the area is supplied by cables accompanying the line, and for the purposes of this approximate calculation, it may be taken that the load is symmetrical along them, so that the average load may be taken as half the total, and the loss as that due to half the current carried the extreme distance. (Obviously the loss may be calculated much more minutely than this for any given distribution of cars, gradients, &c.) The current being 532 amperes, half of it is 266 amperes. Then we get total loss in watts—

For current supplied to J	93 × 3·125 × 15·8 =	4,820
And the balance	266 × 3·16 × 15·8 =	13,300
		18·12 KW.

As 58·45 watts cost £1 in a year's working, the money cost of this loss will be $\frac{18{\cdot}120}{58{\cdot}45}$ = £310 in round figures, and as the interest cost of the cables should equal the total cost of distribution (strictly speaking, that portion of the cost affected by system adopted) to the trolley wire, the total cost under these heads for the lines considered would amount to £620 per annum. But the use of the trolley wire where practicable will reduce the cable cost and interest item below this theoretical amount, and a table follows giving the actual feeder cost. Inspecting the plan, it is clear that the junction I is about the centre of gravity of the load beyond the 3·16 miles on the western sections. This is 5 miles from T, and the load to be delivered is that for 15 cars = 45 amperes. The energy lost in these boosted feeders is more costly, having been transformed by the boosters, whose efficiency is rarely over 75 per cent. The value of the boosted unit must therefore be taken at ·75 × 1·33 = 1d., the value of w becomes 44 instead of 58·45, and $t^2 = \frac{251 \times 44}{58{\cdot}45}$ = 189 nearly, or t = 13·75 and $\frac{13{\cdot}75}{\cdot 045}$ = 306 amperes per square inch as best density. Drop per mile is 13·75 volts.

The boosters would only be necessary to make up the drop in the lengths beyond the 50-volt drop limit, so that this lower density should, strictly speaking, apply only to the excess of cable length beyond 3·16 miles. It will be better, obviously, to use a conductor of uniform section to give the same drop. In the case of the western section then the drop will be 50 + (13·75 × 1·84) = 75·3 or 15·06 volts per mile, showing that the refinement makes little difference in this case. On the eastern section the drop will be 50 + (13·75 × 1·16) = 65·95, say 66 volts, or 15·3 per mile.

The losses will thus be:—

Western 75·3 × 225 =	16,942 watts.	
Eastern 66 × 45 =	2,970 „	
	19,912, say 20 KW.	

Of this 20 kw., 270 × 50 = 13,500, the unboosted cost £1 per 58·45 and 6,500 cost £1 per 44, so that the total annual cost of the loss in these feeders will be:—

$$\frac{13{,}500}{58{\cdot}45} = \text{£231 nearly}$$

$$\frac{6{\cdot}500}{44} = 148 \text{ „}$$

£379 „

The interest on the mains will be somewhat less, owing to the use of trolley wire on the more lightly loaded branches. To this has to be added an annual charge representing interest, maintenance, and running cost of "boosters" to give an output of 6·5 KW. With spare plant 10 KW. might be provided, and would probably cost £20 per KW, say £200. Fifteen per cent. per annum is a proper charge for interest and running expenses on such plant, so that this item would be £30 per annum.

The following is a schedule of feeders on the trolley side, wherever needed to supplement the trolley wires:—

DIRECT FEEDERS.

Line.	Length, miles.	Amperes.	Section Cu. sq. in.	Tons, Cu.	Value.
T J	2·125	98	·277	5·37	£817
T E	·35	247	·700	2·23	337
E D	2·00	165 mean	·470	8·55	1,290
T F	9	187 „	·531	4·35	655
F G	1·25	120 „	·342	3·56	538
	6·625			24·06	£3,637

BOOSTED FEEDERS

Line.	Length, miles.	Amperes.	Section Cu. sq. in.	Tons Cu.	Value.
T C	4·1	225	·672	25·0	£3,775
C I	9	60	·179	·15	23
C B	1·1	75	·224	·22	33
T O	3·8	45	·134	4·63	699
	9·9			30·00	£4,530

Total £8,167.

The cost of distribution on the trolley side is thus:—

Loss in direct feeders, 18·12 KW, worth annually	...	£310
Interest on cables in ditto, 7 per cent. £3,637	...	255
Loss in boosted feeders { 13·5 KW., worth £231 / 6·5 „ „ £148 }	...	379
Interest on cables in ditto, 7 per cent., £4,530	...	317
Annual charges on boosters	...	30
		£1,291

This works out per unit delivered to the cars:—

$$\frac{1{,}291 \times 240}{427{\cdot}5 \times 5{,}475} = \frac{309{\cdot}840}{2{,}340{,}000} = \cdot 133\text{d.};$$

making total cost ·883d., disregarding losses in the return conductors. But the regulation as to P.D. in rails forbids such disregard, and their effect must now be considered.

(To be continued.)

SOME ELECTRIC TRACTION NOTES.

In some respects that excellent monthly periodical, *Feilden's Magazine*—besides being militantly British—is also markedly journalistic; at least, that is the conclusion to which one is forced after reading some of the "engineering notes" of our contemporary.

For instance, in the May issue we notice a couple of abstracts or short notes, both from German sources, and dealing with electric railway work in language that will amuse the expert, and also, we fear, mystify the ordinary reader. In the first of these, we have the substance of a recent lecture by Herr Fischbein, of the Allgemeine Elektricitäts Gesellschaft, upon the use of electric locomotives for ordinary railway work.

The author shows, first, the necessity for using locomotives rather than motor cars and wagons, assuming that an essential part of the task of railroads is the carriage of goods. Then he proceeds to classify electric locomotives, *e.g.*, into normal or narrow, according to the gauge; or else into those (here we quote the abstractor) "which are driven by a stream produced by wires running along the whole line," those possessing accumulators, and those with mixed motive power.

The evidently literal translation of the German word "strom" is rather funny; and the whole sentence reminds one irresistibly of Mr. Punch's old lady who was so shocked at the idea of a tramcar with a naked conductor running along the side.

Herr Fischbein appears to favour accumulator locomotives for such purposes as shunting, or for ordinary traffic of a somewhat infrequent nature upon a long line. We fear, however, that he has not had the financial control of any line where accumulators have been used. There need not necessarily be great complications of third rail or overhead wire about a shunting yard, though, of course, the location is not the most suitable in the world, and even with small traffic on a long line the accumulators to our mind are out of place on the locomotives. They are better employed at intermediate points along the line for boosting or storage purposes.

The second abstract to which we refer, is apparently taken from a proposal lately put before the German Government by the Union Elektricitäts Gesellschaft for the electric equipment of the Berlin Metropolitan and Circular railways. These are at present worked by steam, and, of course, the advantages of electric traction do not really require detailed mention in reference to lines of this character, being, one would think, self-evident and obvious.

The phrasing adopted by the abstractor is very curious, however, and even amusing; it can hardly have been done by a technical man, and hence our remarks as to the "journalese." For instance, the following it—to say the least of it—open to misconception :—"The trains on these railways running on a single line—double lines being too expensive— . . . . . but a high rate of speed cannot be attained without danger so long as steam engines are used." We need not stop to deal with a circular railway, having a single line only. Perhaps the abstractor's meaning will be clear enough; but surely it is not a question of *danger* on lines of this character when steam engines are used.

The high average rate of speed possible with electric traction simply cannot be attained by steam locomotives, and that is all there is about it. The acceleration and deceleration of electric trains are so rapid by comparison with steam that the mean speed is much higher.

It is not much use informing the ordinary or gentle reader, as the abstractor does, that "with electric traction a speed of ·5 kilometre per second can easily be attained, whilst with steam traction the greatest speed hardly reached ·15 kilom." As a matter of fact, 30 kilometres *per minute* is rather fast travelling, even for us, and we are rather surprised that such a tolerably high speed should be proposed for a metropolitan line with frequent stoppages!

Of course, the mistake is obvious, but even granting a correction of figures, what is the point of adding to the above statement the fact that an electric train could run 80·1 kilometres (50 miles) an hour? We quote the decimal of a kilometre to show the exactness of the calculation! Of course an electric train can run 50 miles an hour, and so could a steam train, but probably neither would be able to attain a velocity equal to 50 miles an hour on a line of this nature, with very frequent stoppages.

It is, however, claimed that a mean speed of 50 kilom. (or 31 miles) per hour could be maintained, *including stoppages*. This certainly is a much better showing for electric traction than most of its best friends have dared to hope. Indeed, the abstractor says specifically that it means a saving of 17 minutes in the hour (nearly one-third) on one line, and 15 minutes (or one-fourth) on the other—presumably on the running time.

Economies of 30 and 25 per cent. in the time of running trains are not to be despised, if and when they can be got, and should these estimates prove well founded, they will show abundantly what most of us know full well is the case, that electric traction upon suburban and metropolitan or circular railways, whether overhead or underground, is far superior in every respect to the use of steam locomotives.

The signed articles in *Feilden's Magazine* are, we notice, of a very excellent order, and amongst those published in the May issue there is one concerning the Glasgow tramway system, and the transition thereon from horse to electric working, which well deserves extended notice.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"A.I.M.E." writes:—"In view of the fact that the Board of Trade will not now allow a transfer clause in electric lighting provisional orders, can these orders now be transferred to companies by local authorities? If so, under what clauses of the Electric Lighting Acts can this be done, and in what manner will the arrangement differ from the powers conferred by the existing transfer clauses?"

*** It is provided by Section 11 of the Electric Lighting Act, 1882 (45 and 46 Vict., c. 56), that any local authority who have obtained a license, order, or special Act for the supply of electricity, may contract with any company or person for the execution and maintenance of any works needed for the purposes of such supply, or for the supply of electricity within any area mentioned in such license, order or special Act, or in any part of such area; but no local authority, company, or person shall, by any contract or assignment, transfer to any other company or person, or *divest themselves of any legal powers given* to them, or any legal liabilities imposed on them by this Act, or by any license, order, or special Act, *without the consent of the Board of Trade*. Our correspondent will see clearly from this section that even though a power of sale is granted to the local authority as undertakers, the same cannot be exercised without the consent of the Board of Trade. The transfer clause which used to be inserted in provisional orders finds no place in the form of provisional order suggested in the Electric Lighting (Clauses) Act, 1899. The refusal of the Board to allow a transfer by the local authority must be gathered from the absence of a transfer clause in the order—which might, even in spite of the Act of 1899, be still inserted. We are not cognisant of any machinery in the Electric Lighting Acts whereby the transfer could be effected otherwise than in accordance with the terms of the provisional order. We might add that Mr. Shiress Will, Q.C., in his book on the "Law of Electric Lighting," second edition, p. 18, says:—"It was formerly the practice of the Board of Trade to insert a clause authorising such a transfer . . . . . but the policy of the Board in this respect has recently undergone a change."

"Overloaded" asks:—"In the event of a Municipal Electric Lighting Station creating a nuisance by the emission of smoke, who are the persons who are liable to be prosecuted:— (1) The Municipal Corporation, (2) the manager of the works, or (3) the stoker who is firing at the time the nuisance is created? I am assuming that a nuisance is noticed at some definite time, and that the prosecution is in respect of that one definite nuisance."

*** We have no doubt that a prosecution will lie against the Municipal Corporation, and against them only (See Barnes *v.* Ackroyd, 41 L.J., 114.) We are not aware that a *manager* has ever been held liable in such a case. In the case of Niven *v.* Greaves (1890, 54 J.P., 548), the defendant was owner of a mill which, upon several occasions, sent forth black smoke. The furnaces were constructed on the best possible principles. The defendant had exercised proper supervision over the persons in charge of the furnaces, and the nuisance was proved to have arisen owing to the default of a stoker. The Divisional Court (Coleridge and Fry, L.J.J.), held the defendants liable, and they were fined. It is true that in the case of Chisholm *v.* Doulton (22 Q.B.D., 736), which arose under a Metropolitan Act (16 & 17 V. c. 128. S. 1), with which we presume our correspondent has no concern, employers were *not* found guilty, where it was proved that the furnaces were properly constructed, and that the emission of smoke was entirely due to a stoker's negligence. This was not followed in Niven *v.* Greaves, *ubi supra*.

LONDON COUNTY COUNCIL.

The Council on resuming business on Tuesday last week resolved to lend £10,000 to the Poplar Board of Works for electric lighting purposes at the rate of 3½ per cent. on the instalment system, the first repayment of capital to be deferred for three years. It was also decided to advance £20,000 at the same rate of interest to the Shoreditch Vestry for similar purposes and on account of the £70,000 recently sanctioned by the Council.

The Council resolved, on the recommendation of the Building Act Committee, to approve plans submitted for alterations and additions to the Eccleston Place station of the Westminster Company, and for the erection of an additional boiler house at the Bankside station of the City of London Electric Lighting Company.

Light Electric Railways.—The Highways Committee submitted a report referring to the inquiry held by the Light Railway Commissioners in reference to the Council's applications to construct light railways.

Electric Lighting Schemes.

Battersea.—The Council were informed in January that the County of London and Brush Provincial Electric Lighting Company had applied for a provisional order in respect of small portions of Batterseа, and that the Battersea Vestry had decided to oppose the application. The Highways Committee now stated that the works sought to be authorised by the order have already been executed, and join up certain isolated portions of the Wandsworth area which could not conveniently have been supplied with current without the mains being taken across this small portion of Batterseа. In the circumstances the Council did not offer to the Board of Trade any observations with regard to the order beyond suggesting that, if granted, it should be made to conform with other orders already granted to companies for areas within the county. The Board has since forwarded a draft of the order in the form in which the Board proposes to grant it.

Marylebone.—The Council were also reminded in January that the Marylebone Electric Supply Company had applied for powers in respect of the district of Marylebone in competition with the Metropolitan Electric Supply Company. In the order as deposited certain specified clauses of the Electric Lighting Clauses Act, 1899, were incorporated, although the powers ordinarily conferred upon the Council under London Orders were provided for by the insertion of a special clause, and the usual London subway clause. The Council were of opinion, however, that the order should be in the form hitherto adopted for London orders; and the Board of Trade was asked to so amend the order as to make it conform with those previously granted to companies in respect of areas within the county, and also to make certain other amendments in the order.

It appeared from the report of the Highways Committee that the Board of Trade had now forwarded a copy of the order in the form in which it was proposed to grant it. The clauses usually inserted in electric lighting schemes relative to London have been set out at length; the Board has inserted in the order the clause asked for by

the Council providing that the date of purchase shall be 42 years from 1889; and provision is also made, as suggested by the Council, for the supply under the order being by continuous current. The Council also suggested that in this and all other orders which might be granted this year the maximum price to be charged for current should be 5d. per unit. The price laid down in the Marylebone order as first drafted was 13s. 4d. for any amount up to 20 units and 8d. for each unit over 20 units; and in the order as amended the price has been altered to 10s. for any amount up to 20 units, and 6d. for each unit over 20 units. The Highways Committee still thought that, having regard to the prices actually charged by local authorities and companies in London, the maximum price proposed by the Council was a reasonable one, and they mentioned having asked the Board of Trade to reconsider the question, and also to make further amendments of a formal character.

Lambeth.—The Committee stated for the information of the Council that the Board of Trade had decided not to grant the application made by the South London Electric Supply Corporation for an order relating to a portion of the parish of Lambeth, included in the area under the London Electric Supply Corporation Order, 1889, but excluded from the operation of the Lambeth Order, 1892, which was granted to the Vestry and subsequently transferred to the South London Electric Supply Corporation.

ELECTRICITY AND THE STEAM RAILROAD.

There may be a certain instinct of selfishness in the attitude of enmity to the electrical tramway that characterises English railroads. Already in America the outcome of electrical tramway enterprise has been a further development in competition with the steam railroads. Already there are several interurban roads in contemplation each over 100 miles in length. Soon New York and Boston will be thus joined by a line of about 200 miles, and there is one now under construction across the State of Ohio. In Indiana one is rapidly coming to completion nearly 200 miles in length, and so runs the tale all over the United States. It appears to us that absolutely new construction will be far more likely to succeed than any conversion of old lines, and on this account America, which is so poorly provided with either population or railroads per square mile of area, is likely to see a good deal of future railroad development carried out along electrical lines. This cannot so well be the case here. The New York *Electrical Review* points out that the relative advantages of electrical and steam power cannot well be calculated on ordinary statistical bases. It has been proved over and over again that electrically equipping a line reduces operation costs, and creates a demand for transportation which has hitherto been latent. An instance of this in America is an interurban road in Michigan once operated by steam. In one year of electrical development, its business increased eleven-fold. It is a matter of common observation that on our English steam-worked tramlines one might easily walk three miles in preference to waiting for a car, whereas the more frequent electrical service picks up a passenger before any great distance has been covered by him. Interurban electric lines may not find so great a place in England, but there is still room for them. If the Behr line be really carried out between Manchester and Liverpool, it should prove a very paying investment. We may suppose that the promoters will have been sufficiently wise to consult some engineer on the laws of inertia, and that due attention to moderation of curvature will be enforced. Given moderate curves—a not difficult accomplishment across flat and mossy South Lancashire, and Behr's line ought to be a success. We sincerely hope it will be so built as not to bring out the ill effects of curvature, for its success would be a great help to other schemes. Our contemporary does not expect much from the trolley system on electrical lines. The unprohibited third rail still leaves something to be desired, especially on lines with only semi-private rights of way.

THE ROYAL SOCIETY CONVERSAZIONE.

The exhibition of electrical apparatus at the Royal Society Conversazione on 9th inst. contained nothing of striking novelty. A period of over production in electrical discovery appears to have been followed by a period of depression. Such sensational inventions as Röntgen rays, wireless telegraphy and others that we have been in recent years accustomed to, are not likely to be equalled for some time to come.

A clock controlled at a distance by wireless telegraphy was exhibited by Mr. Richard Kerr, F.G.S. A receiving instrument with a coherer was attached to the clock. A transmitter in another part of the room gave rise to electric waves, which acted upon the coherer and set the works of the clock in motion. The experiment was intended to show the possibility of directing the movements of torpedo boats, or of regulating a number of clocks from a standard clock in a central position. The latter application must become impossible as the installation of wireless telegraphy for other purposes progresses, since there is no known method at present of protecting clocks from electric waves from other sources than the standard clock.

The Cambridge Scientific Instrument Company exhibited improved forms of standard resistance coils. The coils are of bare wire wound on mica frames, and are immersed in oil of high insulating properties, which can circulate freely in the vessel. The temperature of the coil is read from a thermometer immersed in the oil. One of the coils has a platinum wire wound parallel to the standard platinum silver wire on the same frame. By taking advantage of the different temperature coefficient of these two wires the temperature of the coil can be determined with great accuracy.

Interesting models illustrating leakage from electric tramways were shown by Mr. A. P. Trotter. Equipotential lines were drawn experimentally by Prof. W. G. Adams' method. The lines of current flow were drawn at right angles to the equipotential lines. One model represented the case of a tramway with a large number of cars uniformly spaced, and the other the case of a similar supply of current, but with the extremity of the line "boosted" down to the potential of the end nearest the works. The maximum height of the second model was half that of the first, showing the great advantage of the "boosted" system.

Mr. Killingworth Hedges exhibited jointing boxes and aigrettes used in the re-arrangement of the lightning conductors of St. Paul's Cathedral, and various other specimens and drawings to show the difference between the new system and the old. The original system for the protection of the Cathedral from lightning was installed under the advice of the Royal Society about 1756. This was replaced in 1872 by what was considered the most improved system, and now it has been still further improved by Mr. K. Hedges. The new aigrettes have a large number of points to replace the single point of the old conductor. It would be risky to predict that the latest system affords complete protection till Nature herself has tested it.

An electric micrometer exhibited by Mr. P. E. Shaw appears to have reached high-water mark in the measurement of minute distances. The first contact of two pieces of iridio-platinum is indicated by a telephone and battery in circuit with the contact pieces. The movable piece is actuated by a fine screw and a system of three compound levers. The reading is taken by a telescope from a divided circle mounted on the screw. Movements as small as $\frac{1}{200}$th of a wave-length of sodium have been measured by this instrument, *i.e.*, about one ten-millionth of an inch.

Prof. Minchin showed that a glass tube containing helium could be made to flash by electric waves transmitted from some distances and received by a copper plate connected to electrodes in the tube.

A pretty experiment was shown by Prof. S. P. Thompson. A number of straight permanent magnets were enclosed in glass tubes, which were weighted with mercury till their specific gravity was the same as that of the water of a tank in which they floated. A solenoid dipped in the tank and energised caused the magnets to perform strange evolutions.

CURRENT SPECIFICATIONS.

X.—THE CENTRAL ELECTRIC SUPPLY COMPANY'S PLANT.

Summary.

Extent of Present Specification.—Section I. Engines and three-phase generators.
Section II. Motor Generators.
Section III. Switchboards.

System.—Generation at one point of high tension three-phase currents 50 ~ 6,000 v. distribution to various central stations where transformation takes place through motor-generators to direct current at 450 volts.

Number of Generating Units.—Two.

Size and Type of Engines.—Messrs. Willans & Robinson's vertical, inverted, triple expansion three-crank type, "3 V" size.

Output of Engines.—Each to develop 1,200 I.H.P. at 230 revolutions working condensing with 190 lbs. steam pressure, and to be able to give 20 per cent. overload for periods of one hour without injury.

Output of Alternators.—Each to develop at 230 revolutions 260 KW. in each phase, or 780 KW. in all. Voltage to be 6,000 volts between conductors, or 3,460 volts between any conductor and earth. Each machine to be capable of giving full output with a power-factor of ·85, and to develop an overload of 20 per cent. for one hour without injury.

Number of Motor-Generators.—Six.

Type and Size.—Each to consist of an induction type three-phase motor, wound for 50 ~ 6,000 volts, direct coupled to direct-current machine, capable of developing 230 KW. at 450 volts at a normal speed of 400 to 450 revolutions per minute.

Switch gear.—A complete set of switchboards to comply with the requirements of the specification, to be included with offer.

Date of Completion.—To be stated in tender for each of the three sections.

Penalty for Late Delivery.—£50 per week for Section 1.
£50 do. do. 2.
£20 do. do. 3.

Stipulations as to Wages paid to Workmen.—None.

Stipulations as to Removal of Foreman.—Satisfactory.

Arbitration.—Satisfactory.

Date for Receipt of Tenders.—May 22nd, 1900.

This specification, prepared by Prof. Kennedy and Mr. S. T. Dobson, well deserves careful study. It indicates the probable line of development in the future of many of our direct current stations, and reminds us that in all likelihood the so-called central station of the present will be merely a transforming and distributing centre in the future, receiving electric energy at high pressure, and supplying to existing networks energy at suitable pressures for motors and lamps. The Central Electric Supply Company, Limited, has been formed to supply "electricity in bulk" to the St. James's and Pall Mall Electric Lighting Company, Limited, and the Westminster Electric Supply Corporation, Limited, and the present instalment of plant is but for a preliminary attempt to relieve the pressure upon some of the Westminster Company's generating stations where extensions along the lines of additional steam generators are impracticable.

It is intended that the two generating units here asked for shall be installed at the Eccleston Square station, and that the motor-generators shall be erected in pairs at the Davies Street, Eccleston Square, and Millbank Street stations of the same company.

The longest distance over which power will be transmitted at high pressure in this instance is 3,100 yards.

It will be noted that the engines are specified not only as to output and speed, but also as to type, size and manufacture, so that as regards that portion of the specification there is little to be said. The steam consumptions and efficiencies asked for are high, but not at all impossible under the given conditions.

The generator specification allows more latitude. The machines are to be connected end-on to the engines, and should have rotating field magnets and stationary armature windings. The armatures are to be *star* connected, having the centre point earthed, the field magnets being wound for 450 volts.

The machines must be so designed that a short circuit maintained for five minutes does not damage the armature, and :—

Contractor to state in tender how far it would be possible to provide an induction winding on field magnets sufficient to drive generator as motor should its field circuit fail when working in parallel with other generators, and what additional cost for such arrangement would be. Also to state how far, if at all, such additional winding would affect efficiency of combined set.

Direct coupled exciters are to be provided which may be used if devised in conjunction with a supply from the low-tension omnibus bars at the station. The motor-generators are to comply with the usual high character of design and requirements insisted upon by Prof. Kennedy, the combined efficiency at full load being specified not to be below 88·5 per cent.

A diagram of connections for the high tension and exciting circuits is given, and offers for the complete switch gear must be submitted.

Although the work is divided into three sections, it is evidently the intention to make an inclusive contract with one firm, and thus maintain their responsibility for successful completion intact.

As regards both generators and motor-generators, it is stipulated that :—

Tenders will only be considered for generators made by firms which have already manufactured three-phase generators of large size which have been in successful use for at least 12 months.

This read literally would practically prevent any British firm tending with any hope of success, but we believe that any offer from manufacturers of repute of alternating current machinery would be treated on their merits.

The general conditions are, on the whole, fair and suitable for general acceptance. The arbitration clause reads :—

Should any dispute arise as to the true intent and meaning of these general conditions and regulations, and the formal contract to follow hereon, or of the specifications, drawings, schedules, the fulfilment thereof, or the settlement of accounts, or as to the value of any additional work to which the schedule rates cannot be applied, the same shall be referred to the President of the Institution of Civil Engineers for the time being, or some member of the Institution nominated by him. Any decision, interim or final, of the arbitrator so appointed, shall be finally binding and conclusive upon all parties.

The only modifying clause is the following, which may, with Prof. Kennedy as engineer, be accepted with little risk :—

Every part of the work must be done to the satisfaction of the engineers, whose directions are to be followed in every respect, and whose opinion on all questions relating to the works is to be conclusive and final.

Having regard to the arbitrary powers claimed by many engineers, the following clause, dealing with power to ask for removal of an incompetent foreman is well worth consideration. It is one which would be willingly accepted by any high-class manufacturer in the country.

During the delivery and erection of work at the stations or sites specified, the contractor shall keep on the ground at each separate place at which work is being carried out a thoroughly qualified foreman, who shall be considered to represent the contractor in his absence; but if any such foreman be found, in the opinion of the engineers, to be incompetent or inattentive, or to conduct himself improperly, the engineers shall have power to remove him by giving seven days' notice to the contractor, and to require an efficient person to be appointed in his stead.

Another good feature in the specification is the limitation of the power of the engineers to vary the work included in the contract to *10 per cent. of the value of the whole contract.* This is a point of great importance, but one rarely made clear in invitations to tender.

XI.—WORKSOP ELECTRIC LIGHTING.

Summary.

Plant asked for.—Complete scheme for electric lighting.

System to be Employed.—Three-wire low tension continuous currents with accumulators, the voltage between middle wire and either of the outers being 220 volts.

Number and Type of Boilers.—Two, of Lancashire type, each 30 feet long and 8 feet diameter.

Fuel Economiser.—To have 128 tubes, and to be of Messrs. Green's or other approved make.

Travelling Crane.—To lift 5 tons and have a span of 24 feet.

Number of Generating Units.—Three.

Size of Steam Dynamos.—One to develop 150 KW. at 440 volts, two to develop 100 KW. at same voltage.

Type of Engines.—To be of inverted vertical pattern, with two or three cranks suitable for compound working, either working exhausting to atmosphere or a jet condenser maintaining a vacuum of 25 inches.

Speed of Combinations.—To be about 400 revolutions per minute for the larger sets, and about 450 revolutions per minute for the smaller sets.

Steam Pressure.—125 lbs. per square inch.

Balancers and Boosters.—To consist of four machines mounted on same shaft, the two inner machines each having an output of 30 amperes at 220 volts, and the two outer machines each 70 amperes at 80 volts. Speed optional.

Accumulators.—Two hundred and forty to be supplied, each with a capacity of 210 ampere-hours, without voltage of any cell falling below 1·85 volts.

Types of Cables.—Feeders may be concentric or twin, insulated with either paper, jute, india-rubber, or bitumen, and laid either in solid bitumen or lead-covered and armoured laid direct in the ground. Distribution may be either three-core or three single cables laid in a trough, insulated in any of the methods mentioned above.

Arc lamp cables to be single core suitably insulated, lead-covered and armoured.

Switchboard.—To be suitable for three dynamos, cells, balancer, and booster, two motor circuits, and two feeders.

Date of Completion.—Five months from date of order.

Penalty for Late Delivery.—*£20* per week for each section.

Stipulations as to Wages paid to Workmen.—None.

Stipulations as to Removal of Foreman.—Satisfactory.

Arbitration Clause.—Satisfactory.

Date for Receipt of Tenders.—May 23rd, 1900.

This specification has been prepared by Mr. A. B. Mountain, M.I.E.E, the borough electrical engineer of Huddersfield, who is acting as consulting electrical engineer to the Council. We have carefully read the general conditions, and must congratulate Mr. Mountain upon compiling a set in which there is very little for any manufacturer to take exception to. The arbitration clause is unlimited, and no unsatisfactory labour conditions are imposed. Possibly the fact that Mr. Mountain acted as secretary to the Municipal Electrical Association during the period when the consultations between that body and the Electrical Plant Manufacturers' Association took place which resulted in the drafting of the "standard clauses" so often referred to in these articles, accounts to a certain extent for the satisfactory nature of these general conditions.

We notice, however, that two-pole dynamos are specified for both sizes of machines. Surely it would have been better to have left the type of dynamo optional, seeing that for these sizes multipolar machines are now so generally adopted.

In specifying the motor balancer, each machine is specified to give an output of 30 amperes at 220 volts, or 6·6 KW., while in the switchboard section each of these machines is said to be of 18 KW. capacity. There seems to be a little inconsistency here.

In each section the time of completion is the same, viz., five months from date of order. It would have been better if the crane had been specified to have been completed at least two months earlier than the steam dynamos, as, under present conditions, it will not be any use to the plant manufacturers, and the Council will not be able to reap the advantage they ought to do in the reduced cost of erecting the plant due to the usual free use of the overhead crane. Although the gross values of the different sections will vary to a very large extent, the penalty for late completion is the same for every section, viz., *£20* per week. In the case of the crane this would probably be far too large a percentage of the total cost for any manufacturer to accept.

THE APPLICATION OF ELECTRIC TRACTION TO EXISTING RAILWAYS.

By Ed. C. de SEGUNDO, Assoc.M.Inst.C.E.

(*Concluded from page* 808.)

With regard to the system of conveying the current from the generating station to the trains, it would not be safe to argue from the experience gained in ordinary tramway work, in which doubtless the trolley system is by far the cheapest in first cost and, under ordinary climatic conditions, also in maintenance. It might be thought that the overhead trolley would apply *à fortiori* to an electric train running through the country. Such electric railways do exist in America and elsewhere, but, in general, for suburban high-speed traffic the overhead system would be practically inadmissible. The simple form of third rail conductor would answer all requirements technically, but if the local authorities objected to an earth return, then a fourth rail for the return current would have to be erected. Two great difficulties still remain to be overcome in connection with this system of conductor, namely, how to deal with the formation of ice on the contact surface of the conductor, and how to bond the rails at the joints if they be used for the return current. Very many systems of rail bond have been devised and large sums spent in experiment, but, so far, no quite satisfactory form of bond seems to have been arrived at, that is to say, satisfactory alike from the point of view of cost and efficiency.

With reference to the conducting power of the earth, the opinion that the contact of the rails with the earth was of material assistance in diminishing the "back pressure," as it were, of the return has been based chiefly upon the results of work in towns and cities, where the "earth" contained a number of gas, water and other metal conduits, and there are many instances on record to show that sometimes a quite appreciable difference of potential has been found to exist between, say, a water pipe and a gas pipe. Recent tests go to show that wet sand or gravel is by no means the good conductor it is supposed to be, and that snow covering the positive and the rail through which the return is made has very little effect upon the amount of leakage. The influence of this knowledge upon the cheapening of the erection of the positive conductor will be very marked, as hitherto it has been assumed that the earth was of great value in increasing the conductivity of the return circuit, and hence must be carefully insulated from contact with the conductor, which, of course, involves great expense.

The questions involved in the consideration of the effect of earth returns upon gas and water mains are of great complexity. If it is the fact that even wet earth is a comparatively bad conductor and if the rails through which the current returns are of ample size and properly bonded, it would appear that the effect of such portion of the current that might find its way back through earth and its contents should be small. From the results of experiments referred to in the preceding paragraph, it will be clear that the degree of conductivity of the so-called "earth," will be conditioned by the number of gas, water, or other pipes contained therein, and their proximity to the railway conductor-rail, hence the various metal conduits in the earth through which a current returns will receive all the current that is going. What is somewhat obscure is why any appreciable volume of current is shunted, as it were, from the return rail. There can be little doubt that even wet earth is a bad conductor. Wet shingle certainly is. The writer discussed this point with the proprietor of Volk's Electric Railway at Brighton many years ago, and Mr. Volk unhesitatingly asserted that when dry the shingle upon which his rails were laid acted as a perfect insulator, and that even in heavy rain the conducting power was inappreciable, as was shown by his tests for leakage. In the circumstances, the ratio of conductivity of the earth to conductivity of rail must approach zero. Of course, any increase of the resistance of the rail due to inefficient bonding would increase the current return through earth, but any serious increase of resistance arising from such a cause would soon be discovered and remedied. It is also not impossible that the corrosion of pipes may be due to other causes, though these would doubtless be aggravated by the passage of an electric current, and the extent of this would depend upon whether the current flowed from rails to pipe, or from pipe to rails. Certainly as far as expert testimony upon the subject is concerned, the exact cause of the corrosion and the degree of responsibility which should be laid upon earth returns, are matters upon which doctors disagree.

The effect of earth returns upon telephone and telegraph lines is another matter, because in this case a small volume of current can produce serious effects.

The means adopted for power transmission and consequently the cost thereof will be largely influenced by local conditions. With 500-volt motors the economical limit of transmission without feeders would be from 7 to 8 miles, assuming a frequent train service and well filled trains. The desirability or otherwise of using feeders resolves itself into

an estimate of the loss in interest on the capital outlay for the feeder, as compared with the fuel saved by their use and the saving in copper on the mains. Clearly, therefore, in districts where coal is dear the limit of economical transmission without feeders would be at a smaller radius than in a locality where coal was cheap or where water power was available at a moderate rental. If the voltage of supply to the motor were raised to 750 or 800 volts, and it could be shown that manufacturers could supply an equally efficient motor to work at this pressure, the radius of economical operation without feeders would be extended to 10 miles or more.

The cost of working such a railway by electricity involves a very careful consideration of all the local conditions. It would not be safe to generalise from the experience of electric tramway working. It is found from the results of many tramways, both here and on the Continent, that the average consumption of energy is about 1 KW.-hour per car-mile for average-sized tramcars, but the coaches for a suburban electric service would have to be much more substantially built than average tramcars in order to stand the speed at which they would be driven and the general rough treatment in shunting, making up the trains, &c., to which carriages on a railway are subjected, and it would hardly be safe to allow less than 6 to 8 KW.-hours per train-mile of five coaches, seating, say, 60 passengers apiece. Taking the total cost of electrical energy, including every expense, at 2½d. per KW.-hour delivered to the motor, the cost per train-mile would be 15d. to 18d. The latter figure is probably a high estimate for such passenger traffic requirements as might reasonably be expected between London and some of the more densely populated suburbs if a cheap and very rapid means of communication were instituted. The general objection to life in the suburbs at present is, that while only a short distance from town, one has to endure all the disadvantages of being out of town without the compensating advantages of life in the real country.

Several instances of suburban electric railways exist, notably in America, and one which is now in progress of extension promises to be an interesting and successful example of enterprise in this direction. The electric railway connecting Detroit and Mount Clements, a distance of about 20 miles, was one of the first high speed interurban electric railways in America. So satisfactory has been the operation of this road that it is now being extended for a further 53 miles to Port Huron.

In the distribution of power five sub-stations will be employed, all of which will be worked in parallel. Thus any heavy loads on any part of the line will come on the several sub-stations at once and relieve the whole line.

The fares will be at the rate of 1¼ cents per mile (under ¾d.), and the speed, including stops, about 27 miles per hour. It is anticipated that between stations the speed attained will be 45 miles per hour.

The problem of an electric suburban service has also been solved by the Union Railroad Company, of Providence. The railroad company operates between 300 and 400 electric tramcars in the City of Providence, and the first of the new extensions, which promise to develop into important feeders for traffic, is about 18 miles long. The method by which the power for the extension was to be obtained called for very careful consideration, and finally an alternate current system was adopted, by means of which it is claimed that current is supplied from the central station in Providence more cheaply than if obtained from a separate plant. The principle is as follows: A rotary transformer sub-station is erected about 14 miles from Providence, and supplied with high tension polyphase currents from the central station, the sub-station supplying the trolley line with direct current in either direction. These high tension currents are not generated from alternators, as is usually the case, but are obtained from rotary converters transforming energy in the opposite direction to that in which these machines usually work.

Within the city limits the cars stop at street corners, but outside the city there are distinct stations at a distance apart varying from a quarter of a mile to a mile and a half, there being 14 stations in the distance between the city limits and the end of the 18-mile line. The line is a single one throughout, with the usual length of double line at stations, and is 4 feet 8½ inches gauge, in all respects as it was previously used for steam service, and, as regards speed, the double truck cars, 50 feet in length, run at 40 miles per hour on some parts of the line. The cars are equipped with air brakes and whistles in every way similar to the old steam trains.

But America is not alone in the enterprising spirit with which electricity is being applied to railways on a scale which hitherto has been considered to belong to the domain of steam only. Italy is taking a very great interest in this development of electric traction, and the subject is being actively discussed, and with practical results. An electric railway is projected between Naples and Benvenuto, a distance of 30 miles. The application of electric traction on the Naples-Castellamare line is being considered. This line is 22 miles in length and has a double line of rails. It is proposed to generate power eventually from the waterfalls on the river Tusciano. In the first instance a steam-power plant is to be erected, which plant will subsequently be utilised as a reserve. A new feature in the service of trains is the provision of express trains every two hours, covering the distance in 35 minutes (nearly 38 miles per hour), and ordinary trains every 40 minutes, doing the journey in 60 minutes.

A project of greater magnitude and importance has received the approval of the Italian Government, namely, the proposal to operate by electricity the trunk lines in the Valtellina, the Licce Colico-Sondrio and the Colico-Chiavenna lines, both of which are now operated by steam. The necessary works are in progress, and it is believed that the lines will be in operation next year. The power for this work will also be obtained from water, the company having secured a concession for using 25 cubic metres per second from a waterfall of 30 metres head on the River Adda (about 8,000 H.P.).

In France very great progress has been made in electric traction, the mileage having been almost doubled up to January 1st, 1900, as compared with January 1st, 1899; and the same activity and progress can be chronicled in Germany and Switzerland. There can be little doubt that we are now, in England, on the eve of large developments in the field of electric traction, which it may confidently be asserted, will before long also take place in South Africa.

As compared with other countries, Great Britain seems to have been very wanting in enterprise, but while this is to a certain extent true, it must be remembered that legal restrictions and other difficulties have rendered it impossible for enterprise to take a practical form. One advantage of this enforced inactivity, however, has been that England is now in a position to profit by the experience of others in the field of electric traction, and thus it may be anticipated that when the application of electricity to various modes of traction once begins in earnest, it will spread with all the more rapidity for having been repressed so many years. The mileage in America has reached the large total of 15,000, over which some 50,000 cars are operated, while in this country the corresponding figures are still insignificant. Now that the many advantages of electric traction over other forms—notably, over horse traction—have been demonstrated beyond all doubt, and as the powers that be are looking with a more kindly eye upon the legal part of the business, it is fair to assume that before many years horse traction for tramways will have become quite obsolete in this country.

It must not be forgotten that engineers in England had solved the main problems connected with electric traction some 16 years ago, and that the City and South London Railway was the first electric railway of its kind in the world.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

AT the meeting on the 10th inst. of the Institution of Electrical Engineers, Mr. S. Evershed read a paper—or, rather, gave an excellent *résumé* of his paper and many additional interesting remarks—on "A Frictionless Motor Meter."

As Mr. T. D. Lockwood, the well-known American electrical engineer, was present, he was asked to open the discussion, and to speak on the paper "and other subjects." He did so, principally devoting himself to the "other subjects." He expressed his surprise at the *personnel* of the

meeting, finding it the same as in New York with many young faces. He had been a foreign member for a long time, but had never had the chance of attending before. He told one or two amusing stories with a delicate flattery of the Institution quietly conveyed, and said he esteemed it a very great privilege in that he was—(hear, hear)—"quite so, here, here." If one could judge from Mr. Lockwood, the American Institution meetings must be dull without him, for he was listened to with interest, although when he came to the paper he admitted he was disconcerted at its title, and perhaps more than anything admired the trouble taken in reading patent specifications—to which Mr Evershed had referred with what was almost an evident sense of pain, for, said Mr. Lockwood, although written in English, specifications might as well be in a foreign language so far as one could learn anything from 99 out of 100 : if the picture was right the text did not agree with it, and if the text was fairly plain then the picture did not fit the text. One thing further he appreciated, and that was how little honesty people of former times had, for they had stolen all our best inventions!

Mr. Ferranti quite understood what Mr. Evershed meant when he said he had worked 10 years at the subject, for few realised the time, disappointments, fruitless work, and cost of making a useful invention. He did not think, perhaps, that Mr. Evershed had quite appreciated how frictionless other meters had been. In 1885 he came across one of his own mercury meters, which ran backwards slowly for two days after being disconnected from the circuit. The cause eventually was found to be that the sixth or seventh wheel in the train was jammed, and the spring on the other wheels was sufficient to give the driving force. The friction, therefore, must have been extremely small. He had found a certain trouble even due to want of balance in the little fan in his mercury meter when it was varnished carelessly, and one side was made a little heavier than the other. It was quite evident that the disturbing forces were then absolutely tiny in their dimensions. The Aron meter practically disregards friction, but it ticks, and he recommended Mr. Evershed to stop the noise in the sample meter exhibited. His own idea on the whole was, that the "frictionless" meter was greater in scientific than in commercial value. Users asked for most absolute simplicity; but, all the same, the meter was "most splendid."

Mr. R. Wood next spoke, and told the meeting he came down to the Hall to make a claim to be the inventor of the magnetic suspension exactly as shown. (He did not, however, favour the members with any evidence on the point.) Mr. Mordey exhibited the Stanley meter, and was of opinion that there are more important things than even low friction. He thought that the meters of the future would be, for continuous currents, of the mercury type, and for alternating currents, induction meters. He described the magnetic suspension of the Stanley meter, and gave some particulars of its working.

Mr. H. L. P. Boot, as a user, was glad "to have a go at manufacturers," who did not seem to appreciate the value of a reliable meter. It had paid him to scrap two types of meter; he had tried four patterns, the first would not "mote," the second moted too freely, the third caused complaints from consumers about the men who were always being sent "to push on the dials," and even the fourth was objected to by some individuals who said that a man with a biblical name could not be expected to design a meter. He then detailed what were the essential points of a good meter for Tunbridge Wells, and explained how useful he found a relay for cutting out a meter altogether.

The next speaker praised electrolytic meters, and was followed by Prof. Ayrton, who ably and at length defended the Evershed meter against the charge of being unworkably complicated. Here was a meter—a dream of a meter—following a perfectly straight-line law. The Ayrton and Perry patent foreshadowed both successful types of meter in use to-day, yet both were becoming complex; but what would the argument be if applied to watches? What chance could a watch have against the simplicity of Alfred the Great's candle? The accuracy of the Evershed meter was attained by annihilating friction. He was glad to see that both this and the Aron meter had gone back to the original idea of measuring really what is paid for, and that meters to measure quantity are being abandoned. Now all the best meters were energy meters, and in that especially he expressed his satisfaction.

Mr. Lockwood rose to point Prof. Ayrton's remarks. He said that the last occasion when meters were discussed at the American Institute similar objections were made; but what did it matter if complexity was attended by effectiveness?

Mr. Aron was anxious to confirm the praise given to energy meters, and characterised as hypercritical the objection made to the Aron meter on the score of noise. He was glad to find this was the sole objection raised to it. Prof. S. P. Thompson added to the congratulations, and viewed the meter as representing a very large amount of careful thought and experimenting. He honestly wished that Mr. Evershed's efforts might be crowned with material success. He humorously referred to an occasion when he found the ticking of a meter a useful indication of the maintenance of supply.

Mr. Evershed replied, and said it was pleasant to find that one's rivals appreciate one's work. As time was limited, he took objections in order. Firstly, complication. He thought the reply could not be put better than Prof. Ayrton had done, but really this was a matter for the manufacturer, who had to make and sell at a reasonable price. He thought Mr. Ferranti was himself very complicated, yet he worked very well and was appreciated; at any rate, the members appreciated him more and more. Secondly, noise. This only required a little rubber on the metallic stops to deaden the noise. He believed the bulk of future supply would be by continuous current. Electrolytic meters were not only messy, but was any mechanical question half so complex as that of electrolysis? Lastly, as to cost. First cost is not the last cost; repairs and depreciation have to be considered. Mr. Evershed closed with a mention of several who had assisted him in working out the meter, and in bringing it so fully and in experimental form before the meeting.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this Journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

7,957. "Improvements in coin-controlled X-ray apparatus." C. A. Allison (F. Neugebauer and F. Distelhorst, United States.) Dated April 30th.

7,979. "Improvements in portable electric lights." A. J. Boult. (E. R. Gil United States.) Dated April 30th.

7,983. "Improvements in electrical signalling." J. N. Maskelyne, Junr. Dated April 30th.

7,989. "Improvements in electric switches." W. F. Jones. Dated April 30th.

7,997. "A new and improved electric gear for cranes." O. Kammerer. Dated April 30th.

8,013. "Improvements in and connected with electric switches." H. O. Farrell. Dated May 1st.

8,015. "A new or improved method and apparatus for electric railways and traction purposes." A. Ballance and S. A. Jefferson. Dated May 1st.

8,016. "A new or improved means and apparatus for collecting current from surface contacts for tramcars, &c." A. Ballance and S. A. Jefferson. Dated May 1st.

8,019. 'Improvements in and relating to winches for raising and lowering arc lamps." J. Dewar. May 1st.

8,022. "Improvements in dynamos and electromotors." A. H. Midgley. Dated May 1st.

8,028. "Improvements in and relating to electric bells or instruments requiring vibrating motions." G. W. Holt and A. J. Hallam. Dated May 1st.

8,061. "Overhead electric protector for conductors." J. A. Poche. Dated May 1st.

8,067. "A new or improved method of tuning electric currents and producing musical sounds by electrical agency." A. T. M. Johnson and G. Guyott. Dated May 1st.

8,103. "Improvements in electric igniters for internal combustion engines and the like." A. G. New. Dated May 2nd.

8,107. "Improvements in or connected with telephone instruments." The British Electric Works Company, Limited, and B. Brander. Dated May 2nd.

8,111. "Improvements in parts of telephone instruments." The British Electric Works Company, Limited, and B. Brander. Dated May 2nd.

8,116. "Improvements in the construction of casing and capping, and in the means of attaching same together for use in connection with electrical installations." F. A. Williams. Dated May 2nd.

8,122. "The improved electrical fusible cut-out." B. C. Bouquet. Dated May 2nd.

8,123. "Improvements in and connected with electric light wall plugs." H. Oppenheimer. (Actien-Gesellschaft Mix and Genest, Germany.) Dated May 2nd.

8,142. "An apparatus for receiving Hertzian waves and translating them into perceptible signs." J. C. Schafer, P. Lippold, and E. Renz. Dated May 2nd. (Complete.)

8,152. "Improvements in transformers." W. L. Wise. (The Actien Gesellschaft Elektricitätsworke vorm, O. L. Kummer & Co., Germany.) Dated May 2nd. (Complete.)

8,160. "Improvements in electric switches." W. Ely. Dated May 2nd. (Complete.)

8,179. "Improvements in electric switch apparatus." W. F. Jones. Dated May 3rd.

8,191. "Improvements in junction boxes for the conduits or casings of electric wires." C. J. Wightman and A. Hudson. Dated May 3rd.

8,201. "Globe or shade holder for gas, oil, or electric light fittings." Dated May 3rd.

8,207. "Improvements in insulated electric conductors and process of and apparatus for making the same." The British Thomson-Houston Company, Limited. (W. S. Clark and G. H. Rupley, United States.) Dated May 3rd. (Complete.)

8,208. "Improvements in high potential electric switches or circuit breakers." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) Dated May 3rd. (Complete.)

8,211. "Electro-mechanical printing apparatus." B. A. Brooks. Dated May 3rd.

8,225. "A new or improved article of manufacture for use in connection with telephone or telegraph instruments." S. Gelder. Dated May 3rd.

8,226. "Improvements in plates for secondary batteries." P. Schmitt. Dated May 3rd. (Complete.)

8,227. "Improvements in or connected with windings for dynamo-electric generators, motors, and converters." V. A. Fynn. Dated May 3rd. (Complete.)

8,234. "Improvements in electric rail bonds." The British Westinghouse Electric and Manufacturing Company. Limited. (C. F. de Redon, United States.) Dated May 3rd.

8,239. "An improvement in electricity meters constructed on the Ferraris principle." Siemens, Bros. & Co., Limited. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated May 3rd. (Complete.)

8,241. "Improvements in electricity meters." M. Kallmann. Dated May 3rd.

8,257. "Improvements in electric ignition devices for gas and oil engines." T. H. Gardiner and L. Gardiner. Dated May 4th.

8,271. "A new or improved electrical switch." P. C. Middleton and W. S. H. Smith. Dated May 4th.

8,274. "Improvements in the manufacture of electrical fuse heads and electrical fuses." H. J. Haddan. (Fabrik Elektrischer Zünder, G. M. B. H., Germany.) Dated May 4th.

8,289. "Improvements in or in connection with insulated electric cables or conductors and the manufacture thereof." G. E. Heyl-Dia. Dated May 4th.

8,290. "Improvements in or relating to insulated electric cables or conductors and the manufacture thereof." G. E. Heyl-Dia. Dated May 4th.

8,293. "Improvements relating to electrical installation and distribution." J. F. Smith. Dated May 4th.

8,299. "Improvements relating to two-liquid primary batteries and regenerating the same." J. Y. Johnson. (H. J. Dercum, United States.) Dated May 4th. (Complete.)

8,300. "Improvements relating to two-liquid primary batteries and regenerating the same." (H. J. Dercum, United States.) Dated May 4th. (Complete.)

8,315. "Improvements in electric switches." W. F. Jones. Dated May 5th.

8,344. "Improved double pin plug for electrical connections." F. H. Minn and The Sun Electrical Company, Limited. Dated May 5th. (Complete.)

8,347. "Improvements in or relating to the 'trolley head' employed in connection with electrically propelled cars or vehicles." J. Taylor and A. Hudson. Dated May 5th.

8,351. "Improvements in electro-medical batteries." L. Petich. Dated May 5th.

8,357. "Improvements in electricity meters." G. Hookham. Dated May 5th.

8,361. "Improvements in apparatus for switching electric currents on and off, specially suitable for lighting telephone switchboards." F. Gill, R. Gilmour, and P. H. Claxton. Dated May 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

12,829. "A new or improved apparatus for electrically signalling on railways." R. Muschamp. Dated June 8th, 1898. Relates to means for electrically indicating on an engine or train whether one or more blocks of the line ahead are clear or blocked. The general arrangement of contact circuits and rails are shown in diagrams which are too complicated for the purposes of abridgment. 4 claims.

12,841. "Improvements in contact rings for electric glow lamps." Siemens Brothers & Co., Limited. (Siemens & Halske Aktien Gesellschaft.) Dated June 8th, 1898. Incandescent lamps. Caps are made with small openings of an unvarying size to receive lamps with uniform necks which may be secured without cementing materials, while the remaining parts of the caps are made of any desired sizes and shapes to suit different holders. The lamps and caps may be connected as described in Specification No. 12,899, A.D. 1891. 1 claim.

13,569. "Improvements in jointing electric cables." J. H. Barker. Dated June 17th, 1898. Relates to joints for concentric and other cables which may be disconnected for testing, &c., purposes. Junction pieces are clamped to each section of the cable, and are formed in two parts with vertical extensions carried above the insulating material. These are mechanically connected and finally electrically connected above the general body of insulation. The electrical connection can thus be broken without disturbing the main connection. A junction piece having a vertical extension is clamped to the outer conductor. A pair of connectors are separated by insulating material, and mechanically connected by insulatad bolts. Connection is then completed through a bar. Similarly the other conductors are connected by clamping devices. Modifications of the double connectors are described. One form is fitted with a screw clamping device, and is adapted to be bolted to the base. In other forms, the connectors are arched, and in a special form for use with twin conductors a pair of clamps is bolted to an insulating plate. 2 claims.

13,580. "Improvements in secondary electric batteries or accumulators." S. W. Hart and E. J. Clark. Dated June 20th, 1898. The plates are held together by insulating bolts which pass through retaining bars through holes in the plates, and through holes in insulating washers placed between the plates and acting as separators. The lugs of the plates of one polarity are connected together by casting on them a bridge with a main central contact piece in which is a tapered hole and which is connected with a similar piece of another cell by a tapered bolt having a core of copper or other good conducting material in it. 4 claims.

13,667. "Improvements in electric arc furnaces." P. Q. Day and the Acetylene Illuminating Company, Limited. Dated June 20th, 1898. Arc furnaces for operations such as carbide-making, in which inflammable gases are produced, are provided with vent holes in their sides for the lateral escape of such gases from about the level of the arc. Two sides of a furnace may consist of movable firebrick or other pieces or doors which are closed successively as the product of the furnace accumulates and fresh material is added. The furnace consists of a metal bottom carrying two fixed vertical sides to which metal doors are hinged and latched. The bottom contains the lower carbon electrode. Each door has a vent tube inclined upward to retain the materials; gas channels are formed in the materials by introducing an iron rod. 4 claims.

13,702. "Improvements in dynamo-electric machines and electric motors." H. F. Joel, jun. Dated June 20th, 1898. Relates to the field-magnets and armatures of dynamos and motors which are constructed with graduated cores and coils for the purpose of obtaining an even distribution of magnetism in the neighbourhood of the poles. A simple form of magnet is built up of three iron strips with bent up ends, which collectively form the pole-pieces, and a coil is wound in the central space so as to embrace all three strips while smaller coils are wound in two intermediate spaces so as to enclose first two and then one only of the strips. The invention can be applied to an internal field-magnet for a dynamo wherein the strip cores are replaced by a solid or laminated core tapered off and provided with slots at the poles. Amongst other advantages sparking at the brushes is prevented. 1 claim.

13,818. "Improvements in or relating to coin operated signal apparatus for pay station telephones." W. P. Thompson. (H. R. Mason and E. D. Wolmer.) Dated June 21st, 1898. For each denomination of coin, which can be paid, a different shoot is provided which has just the width of the coins it is intended to take and is made of a corresponding number of similar sections each bearing a pair of light spring terminals and communicating with the next section. The terminals are in a circuit including part of the primary circuit of the telephone; consequently one, two, three, or more clicks are heard at the central office, according to the coin paid, as it bridged the gap between each pair of terminals in its shoot. 10 claims.

13,827. "Improvements in speed varying devices and electric motors for use therein." R. Bellfield. (R. H. Hassler.) Dated June 21st, 1898. Relates to alternating current induction motors, and more particularly to means for varying the number of magnetic poles produced by the primary winding of such a motor. The coils constituting the said winding are wound in two sections, which are connected in series, and the number of poles is changed by reversing the current through one of the sections. Windings for two-phase machines are also described, one of which is adapted to produce either 2 or 6 poles, and the other either 8 or 24 poles. The provisional specification describes the use of such motors in an arrangement for varying the speed of a shaft or pulley, consisting of two alternating current motors running at different speeds, and so arranged that their resultant speed is either the sum or the difference of their individual speeds. 3 claims.

13,861. "Improvements in and connected with the electro-deposition of copper and other metals on rotary cathodes." W. E. Heys. (E. Dumoulin.) Dated June 22nd, 1898. Electrodes.—Refers to the process and apparatus for the electro-deposition of copper and other metals upon rotary cathodes described in Specifications No. 16,360, A.D. 1895, and No. 2,709, A.D. 1897, in which the rotary cathodes are brought into contact with certain organic membranes and materials called impregnators. Consists in treating these impregnators with formic aldehyde, to render them more or less insoluble in the bath. 2 claims.

13,942. "Combined standard and portable electric light." F. Thomson. Dated June 23rd, 1898. A lamp and a reflector are carried by a holder on a brass tube in a wooden handle, and provided with a long flexible connection. The lamp may be carried about, or the tube may be placed on a pin carried by a metal box which is supported near a wall by a screw, and a long vertical tube extending from a floor flange and containing the supply wires. A coupling is secured in the box by a wooden backing and a cover-plate; the plug is attached to the flexible conductor, and rests on a slotted shelf when not coupled. The arrangement is especially applicable in hospitals. The pin may be hinged to the box, so that it may be inclined with the lamp. 3 claims.

13,969. "Improvements in trembler interruptors for electric currents." A. Wydts and O. Rochefort. Dated June 23rd, 1898. In trembler apparatus in which a rod dips into a mercury cup, it is connected to the extension of the vibrating armature by a strip of foil or other flexible material. By this means the rod moves vertically without oscillating and splashing. The foil may be replaced by a ball-and-socket joint, spring, or other similar connection. 1 claim.

13,999. "Improvements in and appertaining to electric stop motions employed in machinery or apparatus for elongating or drawing strands of cotton and other fibres." W. Tunstall and J. Crabtree. Dated June 24th, 1898. Relates to electrical stop-motions. One of the rollers, preferably the upper one, is made concave, and the sliver guides are arranged in two sets which are mounted upon the cap bar in such a manner as to be adjustable with regard to one another and the rollers. By this arrangement, the top motion is brought automatically into operation when the sliver becomes too thin, as well as when it fails altogether. For causing the stop motion to be brought into operation when the silver is too thick, adjustable studs, pins, or projections in the electrical circuit of the stop-motion, are mounted in such a position above the top roller that the circuit will be completed when the roller is raised or tilted through the passage of a thick sliver. 3 claims.

14,012. "Improvements in electric light fittings." H. C. Brown. Dated June 24th, 1898. A swivelling joint for an electrolier, pendant, or arc lamp is constructed of a ceiling plate carrying an insulated ring and socket connected by binding-screws with the supply conductors. A cup is screwed on the ring and supports a spherical flange on a tube so that this can be turned in any direction. The tube of the electrolier is supported by insulating material in a coupling attached to the tube. One electric connection is made through the cup, tube, coupling, and a binding-screw and wire. The other is made though a spring-pressed plunger in the socket, and a plate supported with a stem and binding screw by insulating material in the tube. In a modification, for attachment to a supporting tube, the ring is of cylindrical form and is connected by a coupling ring and intervening insulation with a flange on the supporting tube. The coupling and tube may be in one piece, screwing into the spherical supporting piece. A groove may be provided in the upper part of the joint to support an india-rubber mantle, to keep it dry when used out of doors. 3 claims.

14,058. "Improved means for operating electric railways by a combination of alternating and continuous currents." C. Poliak. Dated June 25th, 1898. Electric railways and tramways are worked with high-pressure alternating currents in the line wires which are converted into low-pressure continuous currents for driving the motors. The transformers may be placed on the line or on the vehicle, or on both, and the current is rectified on the vehicle by electrolytic apparatus, such as is described in Specifications No. 24,698, A.D. 1895, and No. 23,442, A.D. 1897, or otherwise. 4 claims.

14,059. "Improvements in apparatus for producing radiation and light by electricity." C. H. Stearn and C. F. Topham. Dated June 25th, 1898. Relates to lamps for producing radiation by electric discharges directed against bodies in exhausted vessels, as described in Specification No. 21,218, A.D. 1896, and provided with improved means for automatically regulating the amount of gas in the vessels. The body may have two flat surfaces connected angularly and directly opposed to the electrodes which are supplied with alternating current from a transformer in the lampholder. The transformer may be designed to give a higher pressure when the lamp is cold and of high resistance. Several lamps may be supplied from one transformer on an electrolier. When the lamps are connected in parallel, a resistance is placed in the circuit with each. The bulb has an extension containing material through which sparks may be passed to reduce the vacuum. The spark current may be derived from a separate generator or transformer, or from a part of the whole of the secondary of the transformer, in parallel with the electrodes electric condensers being interposed in the spark circuit to prevent discharges occurring between the spark terminals and the electrodes. Or the spark space may be connected with the bulb by a long narrow tube for the same purpose. The spark circuit is completed through a mercury cup and the armature lever of an electro-magnet which is in circuit with the electrodes, so that, when sufficient current passes through the electrodes the spark circuit is opened. The electro-magnet may be in the primary circuit of the transformer. Continuous current may be used. 7 claims.